OP3000 Series User Manual

TFMS 3.0, 3.1, 3.2, 3.3

76-015087 B
Rev B

THERMA-WAVE, INC.

OP 3000 Series
User Manual

TFMS Version 3.0, 3.1, 3.2, 3.3

P/N 76-015087 B

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THERMA-WAVE, INC.

Corporate Publications

OP 3000 Series
User Manual

TFMS Version 3.0, 3.1, 3.2, 3.3

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NOTICE

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REVISION HISTORY

When this manual is revised, its revision history is updated to document the revision level, publication date, and major changes for that revision

Revision	Date	Notes
A	3/1997	Initial publication
B	2/2000	Updates for TFMS 3.1, 3.2, 3.3 and conversion to new manual format.

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INTRODUCTION

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- Welcome to the Opti-Probe User Manual! VI
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1 WELCOME TO THE OPTI-PROBE USER MANUAL!

Your Opti-Probe Film Measurement System provides you with a friendly, intuitive operating environment. Whether you're a production operator running a measurement, an engineer configuring a job file, or a system manager maintaining the system, the Opti-Probe makes complex tasks easy to perform.

How to use this manual

This manual tells you what you need to know to operate the Opti-Probe. For authorized users, it also explains how to configure and manage the system.

- "What's New in TFMS 3.00" summarizes the Opti-Probe's features and capabilities added through the TFMS 3.00 release.
- "What's New in TFMS 3.1 to 3.3" summarizes the Opti-Probe's new features and capabilities added through the TFMS 3.1 through 3.3 releases.
- Section 1, "System Description," describes the different parts of the Opti-Probe
- Section 2, "Operation Summary," describes all the Operator level functions
- Section 3, "Engineer Functions," describes the engineer level operations and setup parameters, except for some custom template functions and all die template functions, which require a vision processor and are described in Section 4, "Pattern Recognition Functions"
- Section 4, "Pattern Recognition Functions," describes the vision processor related operations and setup parameters
- Section 5, "DUV Functions," describes the UV related operations
- Section 6, "System Expert Functions," describes the system's most advanced functions
- Section 7, "System Manager Functions," explains how a System Manager sets up and maintains the system

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- Appendix A provides safety information and UV bulb replacement instructions
- Appendix B lists all the TWI standard films
- Appendix C shows all the TWI standard template patterns
- Appendix D defines the Signal Tower machine event states and includes a blank configuration table

1.1 Conventions

Menu options, buttons, data entry fields, and screen messages appear in *italic* type. When you select some menu options, other menus appear with more options. In some of the sections in this manual, these nested menus are identified by italicized text with slashes between each menu name. For example, *Setup*/*Recipe*/*Custom Template* means you opened the Setup menu, Recipe menu, and Custom Template menu in sequence. Sometimes a new screen appears or the Opti-Probe performs a function after you select a menu option. For more information on the Opti-Probe's TFMS menu structure, refer to your "Getting Started" manual.

On many of the pages in this manual, you'll see Note icons that indicate important information you should remember or help to clarify a concept.

This is a note!

Throughout this manual, you'll see references to Opti-Probe functions that require a vision processor (VP) or an ellipsometer. These are options that are installed on specific models. The following list shows the VP and ellipsometer configurations for all current and discontinued models.

1000, 1100	no ellipsometer or vision processor
1500, 1600	vision processor, no ellipsometer
2000, 2100	ellipsometer, no vision processor
2500, 2600 series	vision processor and ellipsometer

In addition, there are references to "Bulkhead systems only"(Model 2600B), SMIF Indexer systems only"(Models 2600I, 2600DUVI), and "DUV systems only" (Models 2600DUV, 2600DUVI).

1.2 Technical Support

If you have any problems using the system and cannot find the solution in this manual, contact the Opti-Probe Applications Staff at (510) 490-3663, 9:00 AM - 5:00 PM PST.

2 WHAT'S NEW IN TFMS 3.00

2.1 Enhancements and Improvements

TFMS 3.00 provides the following enhancements and improvements:

Operator level

- SMIF Indexer - support for 150 mm wafers and wafer mapping
- Read wafer imprint function in *Main menu*/*Wafer*
- Initialize wafer imprinter function in *Main menu*/*Machine*
- Locked, Must Enter, and Optional fields in Process Information window
- New Chain Editor replaces Cassette Editor for job file chains at runtime
- SPC plot scaling in *Display*/*SPC trend plot* (SPC format plot window)
- Correlation access in *Display*/*SPC trend plot* and all Display parameter windows
- Current/Recall function in all correlation windows
- File function in *Main menu*/*Display*/*Recipe summary*
- Refresh screen function in *Main menu*/*Machine*

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Engineer level

- SMIF Indexer - Wafer mapping, and sorting
- Uniformity and Dispersion Wavelength added to *Setup*/*Database*/*Index* for recall in database displays (e.g., Saved Measurement window)
- New SPC rule in *Setup*/*Database*/*SPC reports*/*SPC rules*
- Access function in *Setup*/*Recipe* menu
- Control function in *Setup*/*Recipe*/*Process* (Process Information window)
- SMIF - Destination cassette (other than source) in *Setup*/*Recipe*/*Cassette*
- Autoload function in *Setup*/*Recipe*/*Measurement* [Custom/Die templates]& *Film* (Measurement setup parameters and Film parameters windows)
- Current/Recall function and Parameter Correlation in *Setup*/*Recipe*/*Correlation* (Correlation parameters window)
- Access to Correlation setup in *Setup*/*Recipe*/*Data output*/*Display control* windows
- Display control for area scan and polar map measurements in *Setup*/*Recipe*/*Data output*/*Display control* and all measurement results windows
- Data filter function in *Setup*/*Recipe*/*Data output*/*Display control* for die templates
- Chain measurement type (Wafer or Die) in *Setup*/*Chain*/*Edit*/*Add* or *Alter* (Add or Alter job file chain entry window) and *Info* button/Use Chain Editor
- Wafer imprint setup in *Setup*/*Recipe*/*Wafer Imprint*

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System Expert level

- Material Characterization parameters in *Setup*/*Recipe*/*Film*/*Mtrl*
- Dispersion parameters in *Setup*/*Recipe*/*Film*/*Fitting*/ *Dispersion*
- UV & Dispersion parameters in *Setup*/*Recipe*/*Film*/*Fitting*/ *Calc* Materials Library in *Setup*/*Library*
- Reference substrate (Si undoped or Crystalline Si) in *Setup*/*Recipe*/*Fitting*/*Calc*

The Material Characterization, Dispersion, and Material Library functions are not accessible in the initial TFMS 3.00 release. These features will be available in future upgrades.

System Manager level

- Transfer function in *Setup*/*Library* (Custom template/Die template /Film/Materials - Library Maintenance windows)
- Force logout, Close job file on logout, and Wafer Imprint Reader (on-line) controls in *Main Menu*/*Administration*/*System parameters*
- New "Production" job file ownership
- Signal tower setup in *Main Menu*/*Administration*/*Signal tower*
- Wafer imprint control in *Main Menu*/*Administration*/*Wafer imprint*

GEM SECS enhancements (refer to your "GEM SECS Manual")

3 WHAT'S NEW IN TFMS 3.1 THROUGH 3.3

3.1 Enhancements and Improvements

TFMS 3.1 through 3.3 provide the following enhancements and improvements:

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Hardware and System - All Levels

- The system automatically turns on the stage vacuum if there is a robot paddle leak. This prevents the wafer from slipping off the stage due to a loss of vacuum pressure.

- All systems are compatible with the new Cognex 5000 series vision processor (VP).

- Limit switches are now checked in TFMS.

- The system now determines if a selftest is needed before wafer is loaded.

Operator Level

- The system informs the user that the Goodness of Fit = -1 when there is a lens focus failure.

- The system now displays a user friendly message before a job file chain measurement is executed, if one or more job files are missing from the selected chain.

- The system now calculates normal incidence transmittance and reflectance values during a measurement. The transmittance value specifies the amount of light that passes through the first film layer to the second film layer for a multiple layer film stack, or through the first film layer to the substrate for a single layer film stack. The reflectance values specify the amount of energy that reflects off the surface of the wafer.

- The system now displays a 0 reflectivity value (instead of a negative value) for reflectivity measurement results if the background signal exceeds the wafer reflectivity (i.e., for very dark nitride wafers).

- The tabular measurement display header now accommodates new database parameters (e.g., thickness calculation and transmittance and reflectance calculations).

- The system now zips (compresses) logged diagnostic data (*Main menu/Wafer/Log* diagnostics) before copying this information to a floppy disk. In a rare case where PKZip may not be installed on a system or does not function properly, a message will appear that says:

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Cannot Zip File, Continue without Compression? with Yes and No options.
In addition, the system now saves an overview text file (ovr_view.log) to the floppy disk, which includes the information shown in the following example.

Stemname	SE251104
Points measured	3
Job file	AMS\CUST\TEST0910
Station number	1
Slot	1
Date/time	25-Sep-1997 11:04:21

- The system automatically optimizes the Y axis scaling in line scan measurement results windows.

- Added a "Mix data" item in the "Data to floppy" menu.

- Added a Halt button capability during wafer load operations (mask alignment).

- PCNF (Precision Center-Notch Find) implementation has been added to the job chain. PCNF uses pattern recognition to find the wafer center and also the wafer notch location. PCNF is currently implemented for 8" notch wafers. PCNF allows for positioning accuracy on a non-patterned wafer without mask alignment.

- PCNF Control at Job File level

  - Report PCNF failure in cassette summary report.

    Error messages in general are suppressed (not displayed) during either "Cassette" or "Job-Chain" modes. This goes for PCNF errors as well. Logging of PCNF failures in the cassette summary report for both modes of operation has been added.

  - Halt capabilty has been added to PCNF.

    "Halt" button is added to PCNF such that halting is possible whether in single wafer mode, cassette mode or job-chain mode.

- A ‘Uniformity’ value, defined as $(Range/(2\times mean))\times 100$), is now provided on the subtraction display screens.

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- Indexer/Robot interaction enhancement. The system will now check robot state before initializing the cassette (*Machine\Initialize cassette stations*).

Engineer Level

- In The *Setup/Recipe/Custom template or Die template - Mask teach*, the system displays an error message and then prompts a user to load a wafer (the Load wafer dialog box appears) if there is no wafer on the stage during a Mask teach operation.

- The *Setup/Recipe/Die template/Dice* and *Sites* and the *Setup/Recipe/Measurement* (for die templates) windows, display numbers on all dice and measurement sites. The wafer map in the above windows now show numbers for all dice and measurement sites within the dice (unless the dice are too small for numbering).

- Added the number of points for template type measurements in the recipe summary. For Custom Templates, the recipe summary will show the "number of sites".
  For Die Templates, it will show "number of dice" and "number of sites".

- Added "Site and Model" data to the recipe summary display.

  A new section, "Die template 'Site, Model and Die' positions" has been added to the Recipe Summary that may be displayed, printed or saved to a floppy file.

  Site positions are given relative to the 0,0 point of any die (in mm) and also relative to the wafer center (0,0) on the reference die (in mm). Model positions are given the same way site positions are. Die positions are given in multiples of die-pitch from the reference die (0,0) (an integer) and also from the wafer center to the lower-left corner (0,0) of the die (in mm).

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- Recipe Summary Additions

  The following items have been added to the Recipe Summary:

  1. Custom template information:

     - Recipe enhancements for "Die templates" have been extended to "Custom templates".
     - Since custom templates may not have dice but may have sufficient structure to support models, the Recipe report is modified to reflect that.
     - Sites and models, if any, are described only from the wafer center. There are no Dice locations.
     - Die template reports are not affected.

  2. Job-file (directory, sub-directory and filename) are now included in all recipe summaries.

  4. The positions of the three alignment masks (if available) are added to the Recipe Summary below the Sites, Models and Dice positions.

- Autoload error messages appear when the *Administration/ Production/Params* incorrectly modify (preempt) the *Setup/Recipe/ Film* or *Setup/Recipe/Measurement* autoload setup. This type of error could occur, for example, when an administrator preempts Production JobFile for auto load and the jobfile has never been set up to do auto-load.

- A Thickness Sum Configuration for Thickness Sums 1 & 2 has been added. The selected layers are shown in a new "Thickness Sums" screen for each thickness sum. "None" is shown if layers have not been selected. Up to six contiguous layers may be defined for each Thickness sum. For example:

  a. Thickness Sum 1 1+2+3

  b. Thickness Sum 2 3+4

- A user can now enable or disable correlation on Thickness Sum 1 and Thickness Sum 2. The correlation applies only to the measured thickness parameters.

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- Real-time measurement windows display new parameters including: thickness calculation parameters, reflectance and transmittance parameters, effective medium component parameters, and other dispersion parameters. Although the system can now measure and save up to 36 parameters, only eleven parameter names can be displayed during a measurement. A user can display SPC trend plots for these new parameters but cannot set up SPC rules for them. There is no SPC specification for the new parameters. If a job file is setup to display SPC trend plots for the new parameters at the end of each measurement, all five types of SPC plots will appear (average, sigma, % sigma, range, % range). A user cannot setup correlation for the new parameters and cannot measure the new parameters using SECS. However, a user can copy the new parameter data to a floppy disk during a Setup/File/Transfer operation.

- In the Setup/Recipe/Data output/Output control - Save Dispersion data option, the system now allows an authorized user to configure a job to save the fitted dispersion parameters (e.g., Cauchy, Critical Point, Effective Medium). Although an authorized user can specify more than 24 dispersion parameters (Setup/Recipe/Film/Fitting/Dsprsn), the system can only save a maximum of 24 and displays a warning message reminding the user of this limitation.

- An authorized user can now select Radial as the Map display type in Setup/Recipe/ Data output/ Display control and in all Display Parameters windows. A Radial display shows the measurement results as a function of radius, rather than X,Y.

- The Display button was removed from all measurement results windows (e.g., *Display/ Saved Measurement*). You must now select the Param button, and then select either a tabular, contour map, 3D map, or Radial display as the Map display type in all Display parameter windows. For *Setup/Recipe/Data output/ Display control*, the Map display type option replaces the Initial display option.

- Measurement setup now allows a feature similar to spatial averaging using the spectrometer which is in reality a spatial selection. Set up the same as regular spatial averaging, the best point for fitting is selected from those measured.

- The spectrometer fitting range is now recipe dependent, allowing the wavelength range over which to fit to be a jobfile parameter.

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- An ACAL accumulation factor has been added.

- A negative correlation function has been added that allows monotonically decreasing correlation. Previously, the transfer function between measured values and reported values had to be monotonically increasing to be accepted. Now, it can be either monotonically increasing or monotonically decreasing.

- An option has been added to include Date/Time information for all selected records in a requested SPC floppy file.

- The system may now be set up to display user selected measurement parameters. This function also allows the user to selectively save measured parameters to the data base.

- Added a "Calculated Data Saved in Jobfile" settings (Yes/No) for the following parameters:

  a. First layer Transmittance/Reflectance

  b. Anisotropy Information

  c. Thickness Sum 1

  d. Thickness Sum 2

- BOX – IN – BOX enhancement for VP mask models

  This enhancement adds a user interface for masking part of a VP mask model. Implemented through the "Mask Teach VP Parameters" screen, new CDBs 2561-2566 allow non-rectangular models that have the effect of masking the mask model. The new CDBs are also accessible through SECS.

  A new entry has been added to the Administration "Access" screen to control who can change the masking mask feature.

- A new feature allows definition of ‘multi-don't care’ boxes for VP mask models.

  Instead of box-in-box, ’multi-don't care’ boxes can now be defined at corners of the die. In this feature, six different regions can be used for ’don't care’ points. The user will see a warning screen if the model that has been constructed is too narrow. The user has the option to continue with the narrow model.

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- Added *reflectivity_normalization* field in the *setup/recipe/ measurement* screen.

System Expert Level

- The system now provides a 'None' option for the BPR calc method in *Setup/Recipe/Film/fitting/Calc* screen. This allows a System Expert or System Manager level user to enable data analysis without including the A profile or B profile data.

- GOF LIMIT Exclusion

  The GOF-LIMIT enhancements have been implemented. GOF-Limit and Statistical outliers can now be independently enabled/disabled in their influence on the contour, 3D and radial maps (contour, 3D & radial) and on the statistics on the maps and in reports. The CDB Parameter GOF_LIMIT_EXCLUSION_ENABLE is #2652 and defaults to 'Disable.'

  Printed reports and screens that show statistics have been modified, such that, if there are not enough good data points, the statistics are printed as asterisks. An exception being that GOF and Residual data are always considered good, even if the measurement being represented is not. GOF_limit and outlier should not be considered for these data.

- An *epsilon* option is now available in *Setup/Recipe/Film/Mtrl/Plot.*

- New vacuum checks have been added via three new CDBs that can be enabled or disabled at the system expert level. These are as follows:

  1. New "Wafer-position vacuum test" feature. A new CDB parameter (2647) enables/disables this feature. Default is OFF since the test takes up to a second per wafer and many users would rather have the throughput.

  2. A new "additional wafer-position vacuum tests" feature. Default is disabled.

  3. Additional Vacuum Wafer-checks During Robot Operations have been added. Customers occasionally have wafer handling problems, supposedly due to electrostatic forces, such that wafers are not properly picked up or dropped off. This feature, when enabled, does several more vacuum checks, mostly on the robot, to assure that wafers are present or absent as expected and to ensure that the robot stops safely, when they are not. Default setting is disabled.

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System Manager Level

- The *Main menu/Administration/Maintenance menu* provides limited access to Service (IOPT) macros. For instructions on using this option, you must attend a TWI customer training class. When a System Manager selects this option, a keyboard window appears, which prompts you to enter a special USER ID and Password. After a System Manager enters this information, the Macro Selection screen appears.

- A new feature, Edit Protected Directories has been added to the *Main menu/Administration/Utilities/other Utilities* menu. This new feature allows a System Manager to protect and un-protect job file directories. Only a System Manager can modify or copy the job files within the protected directories (PJD's). Operator, Engineer, or System Expert level users can only use the job files and save measurement data. When a System Manager selects the Edit Protected Directories option, and then selects the Go button, the Text Editor window appears where a System Manager can add a PJD (protect an existing directory) or edit a PJD (un-protect an existing protected directory).

- Film stack mixing model with fitting implements a stack mixing feature with the ability to fit on the mixing fraction.

- A new cycle selection option, "Type 3", has been implemented specifically for metal line measurements.

- Effective medium fitting has been fixed so that non-fitting fractions are properly scaled.

- For fitting on anisotropic materials an anisotropic value has been added to film stack (and job file) The Anisotropy ratio, N(o), and N(e) can be saved to the data base.

- Tool usage tracking has been implemented with a "TOOL USAGE FILE" feature. This feature creates a new file for every TFMS boot and appends date-and-time-stamped entries for bootup, login, logout, job-file selection, start-of-measurement, end-of-measurement, CDB parameter changes and graceful exit-to-DOS. At bootup, the pre-existing file is compressed using pkzip and archived in a date-and-time unique filename. All files reside in C:\SYSFILES. This feature can be turned on and off using the CDB #2644 (TOOL_USAGE_FILE) by the System Manager.

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- A BulkHead Window control function enables the moving of cassettes with an open BHM window.

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1

SYSTEM DESCRIPTION

Contents

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This section describes the different parts of the Opti-Probe. It covers the basic components, internal systems, facility and power requirements, and general specifications. After you read this section, go to your "Getting Started" manual for an introduction to the graphical user interface software and basic instructions on using the Opti-Probe.

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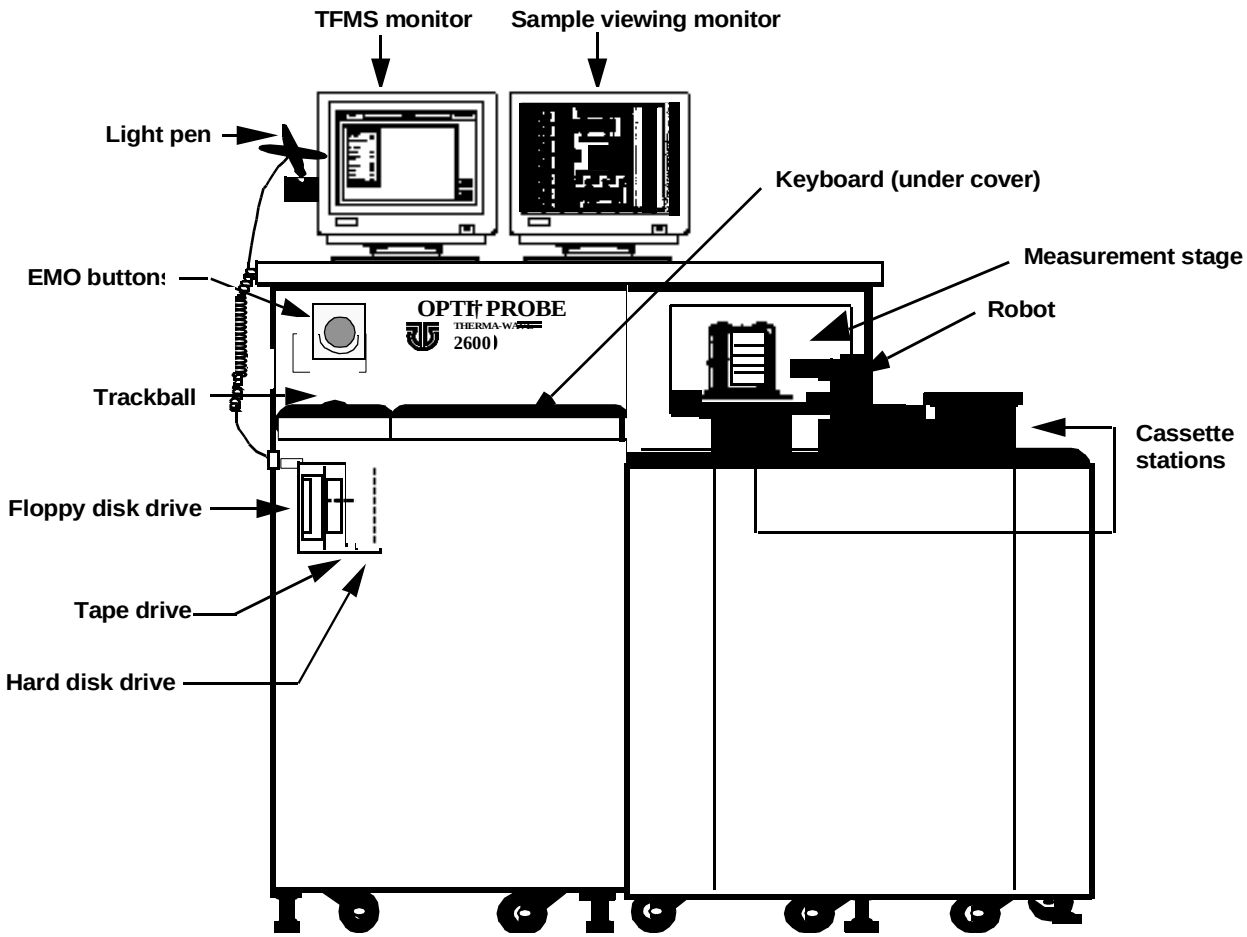
1.1 OPTI-PROBE COMPONENTS

In a typical operating environment, you'll become familiar with most of the components shown in Figure 1.1. You communicate with the Opti-Probe's computer system and control all system activity through the user interface components consisting of the video monitors, light pen, trackball, and keyboard. You save, open, copy, and back up all files using the hard disk drive, floppy disk drive, and tape drive. These are the data storage components. You load and position wafers for measurements using the wafer handling components. These components include the cassette stations, robot, and measurement stage.

Figure 1.1 Opti-Probe components



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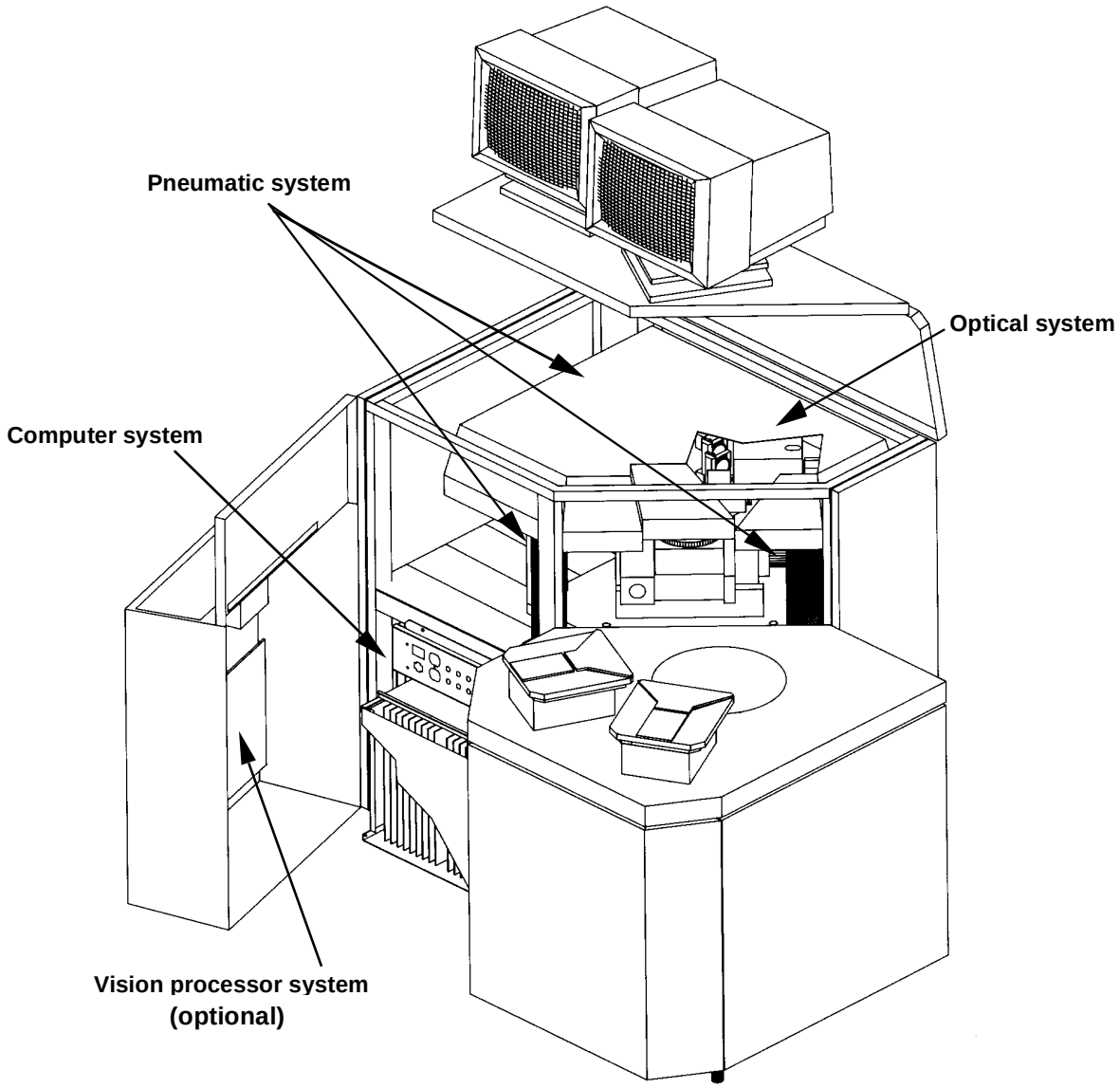
1.1.1 Internal Systems

Figure 1.2 shows a standard Opti-Probe's internal systems.

Figure 1.2 Internal Opti-Probe systems



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1.1.2 User interface components

Video monitors

There are two 14-inch color monitors on the Opti-Probe, the TFMS monitor and the sample viewing monitor.

The TFMS monitor is located at the top left side of the Opti-Probe. It is a Super Video Graphics Array (SVGA) monitor that displays the TFMS software that you use to operate the system.

The sample viewing monitor is located next to the TFMS monitor. It displays the wafer surface in color. When an optional vision processor (VP) system is installed, the Sample viewing monitor also displays the VP output in black and white.

Light pen

The light pen is connected to the left side of the Opti-Probe with a telephone cable. You use the light pen to select menu options, enter data, and perform most Opti-Probe functions. The Opti-Probe has two types of light pens. For instructions on using each type of light pen, see your "Getting Started" manual.

Trackball

The trackball is located on the left side of the Opti-Probe, below the red EMO button. You use the trackball to move the stages and place a section of the wafer in the sample viewing monitor's field of view and under the laser spot. You can only use the trackball when a stage locator appears on the TFMS monitor. For more information on the stage locator, see Section 2, "Operation Summary."

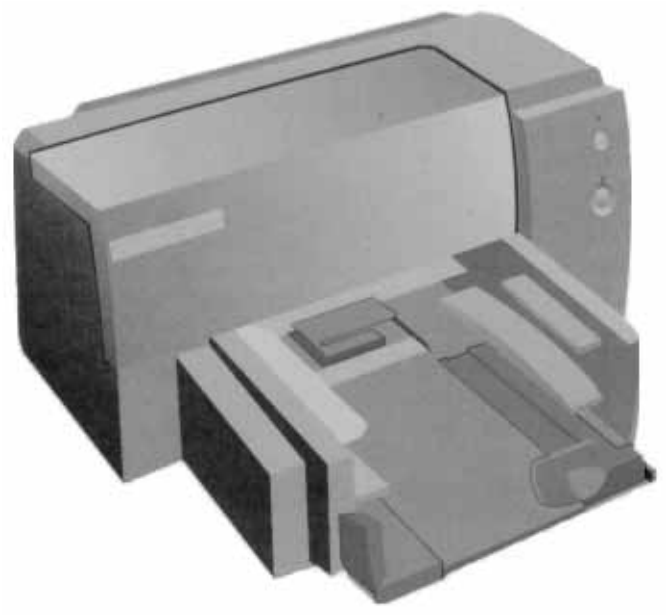
Keyboard

The Opti-Probe's standard PC keyboard is located under a cover below the two video monitors. The System Manager uses the keyboard to back up hard disk files, while Therma-Wave personnel use it to perform maintenance and troubleshooting operations. You can use the keyboard to perform most light pen functions. For best clean room protocol, you should only use the keyboard if the light pen requires maintenance.

Printer

The Opti-Probe's standard printer is currently a Hewlett Packard DeskJet 870Cse™ (see Figure 1.3). You connect the printer to the printer port in the rear interface panel located at the back of the system, and described later in this section.

Figure 1.3 Opti-Probe standard printer(DeskJet 870Cse™)



Emergency Off (EMO) buttons

You should only press an EMO button in an emergency to turn off all power to the system. Under normal operating conditions, you should never press this button. All standard Opti-Probe models an EMO button located at the front of the cabinet, as shown in Figure 1.1. For a complete description of the EMO button, see "Safety and operating precautions," later in this section.

1.1.3 Data storage components

Hard disk drive

The hard disk drive is located inside the Opti-Probe's front cabinet. It stores 540 or more megabytes (MB) of data and is partitioned. The C partition stores the application programs and configuration files, while the D partition stores the measurement data and job files. On systems equipped with an optional vision processor (VP) system, a third partition (E) stores the VP files.

Floppy disk drive

The 3 1/2-inch 1.44 MB high density floppy disk drive is located in a recessed compartment below the trackball and keyboard. The floppy disk drive is designated as the A drive and you use it to copy job files and measurement data to and from different Opti-Probes. Therma-Wave personnel use the floppy disk drive to install and upgrade system software.

Tape drive

The tape drive is located next to the floppy disk drive. The System Manager uses the tape drive to back up the hard disk files. This streaming tape drive uses 1/4 inch QIC-40 format mini tape cartridges. Two or more tapes are required to back up the entire hard disk.

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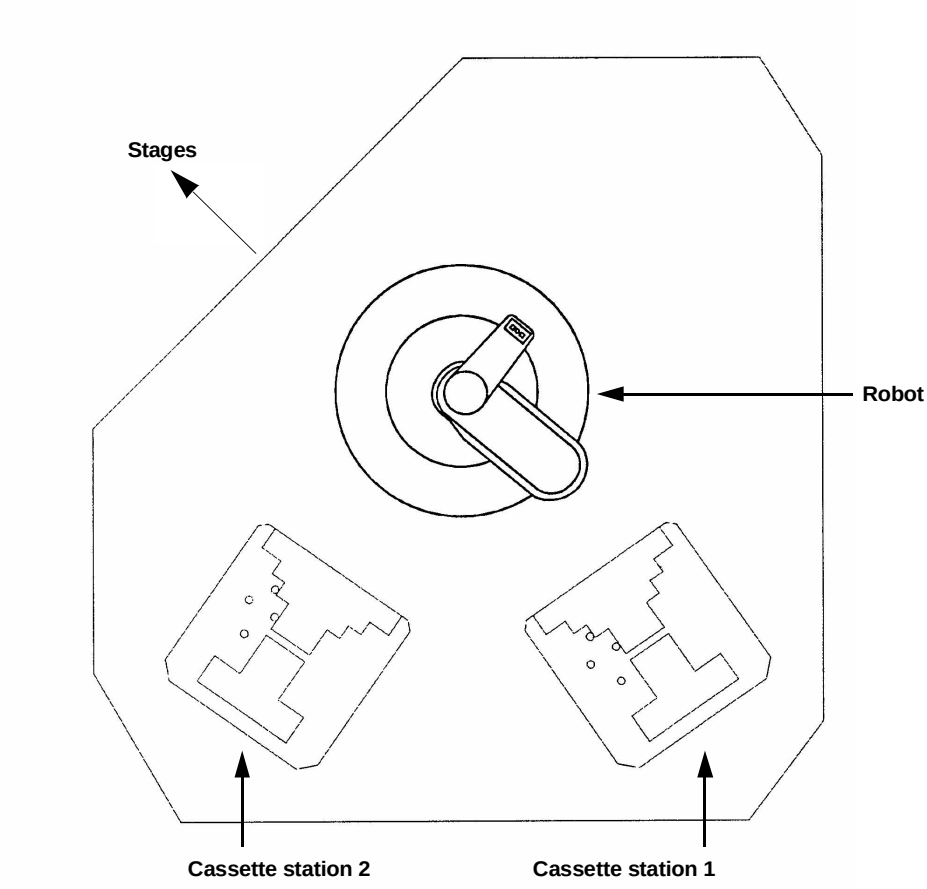
1.1.4 Wafer handling components

Cassette stations

The Opti-Probe can measure wafers that are 4 to 8 inches (100 to 200 mm) in diameter. There are two cassette stations in a standard Opti-Probe wafer handling system, as shown in Figure 1.4. You place a cassette of wafers on either or both stations. They have cassette size detection switches that sense whether each station is loaded with a cassette, and the size of the cassette on each loaded station. When a station is empty, its green status LED is on, which indicates that you can load a cassette of wafers. As soon as the wafer load operation begins, the station's red status LED comes on and stays on until the system unloads the wafer.

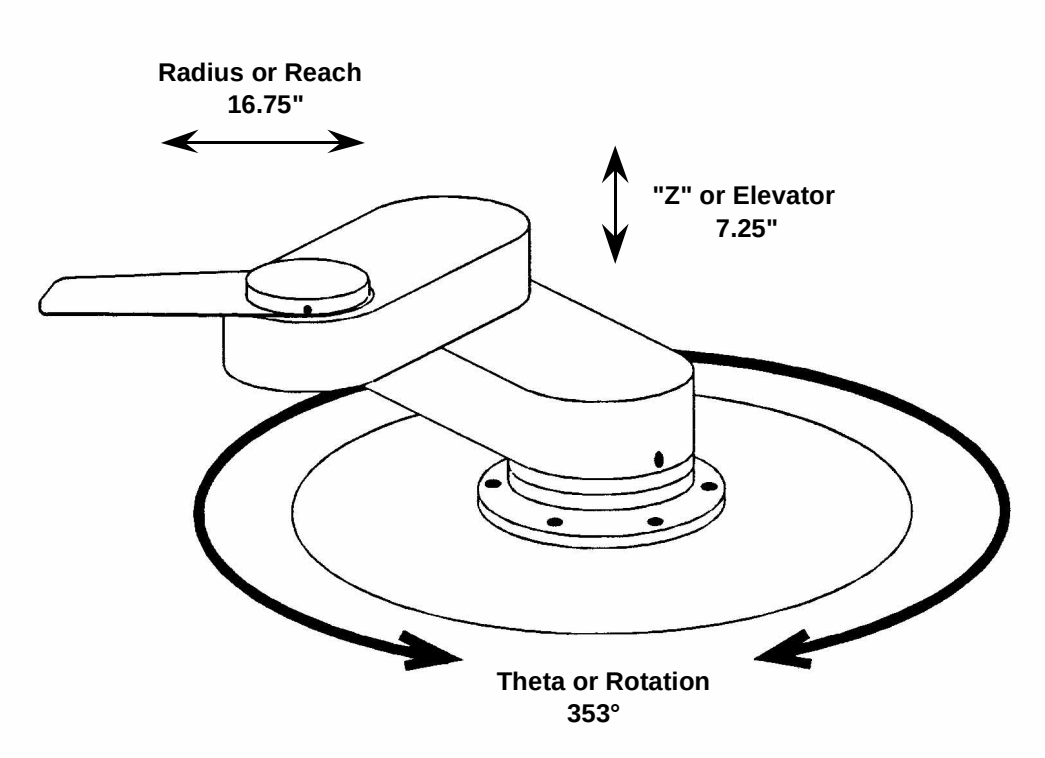
Figure 1.4 Wafer handling system



Robot

The robot is a 3-axis device designed specifically for loading semiconductor wafers. The Z axis moves up and down, the radial (or reach) axis moves in and out and the θ axis rotates the entire robot, as shown in Figure 1.5. The robot transports wafers between the cassette station(s) and the measurement stage. It is a random access robot, so wafers can be loaded from a cassette (and measured) in any order.

Figure 1.5 Robot motions

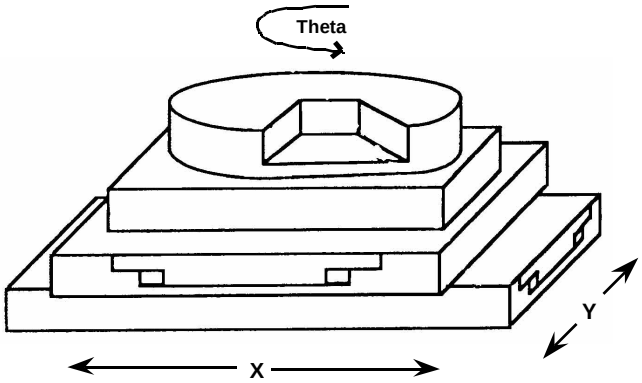


Measurement stage

The measurement stage assembly includes X,Y and θ stages that position the wafer under the laser beam. The X stage moves along a left-right axis, the Y stage moves along a front-to-back axis, and the θ stage moves in a rotary direction, as shown in Figure 1.6. The sample viewing

monitor displays the X stage movement horizontally, the Y stage movement vertically, and the θ stage movement by rotation.

Figure 1.6 Measurement stage (side view)



The theta stage includes a vacuum chuck, where wafers are placed by the robot. A vacuum system senses the presence of a wafer on the stage. Either a 3" or a 5" diameter chuck is installed in the system. The 3" chuck accommodates all wafer sizes (100 - 200 mm). For customer facilities running only 150 mm or 200 mm wafers, a 5" chuck is installed. The 5" chuck provides better mechanical stability for large wafer sizes but cannot accommodate 100 mm and 125 mm wafers.

The stages are controlled by stepper motors. The X and Y stage step size is approximately 0.2 µm, while the θ stage step size corresponds to 0.0003 degree. The X, Y stages have 8" travel.

A reference block is mounted in a corner on top of the stage stack. The internal Si reference, which is measured during an autocalibration, and other reference chips measured during a system test, are mounted on the reference block. For more information on autocalibrations and system tests, see Section 4, "Engineer Functions."

The Center and Flat Find (CFF) detector is mounted on the bottom of the optics plate, near the stage assembly. It is U-shaped, and consists of an LED bar and a silicon photo-detector. During a CFF operation, the edge of the wafer moves between the LED and the photo-detector and the system uses the detector signal to find the wafer center and orient the (major) flat or notch.

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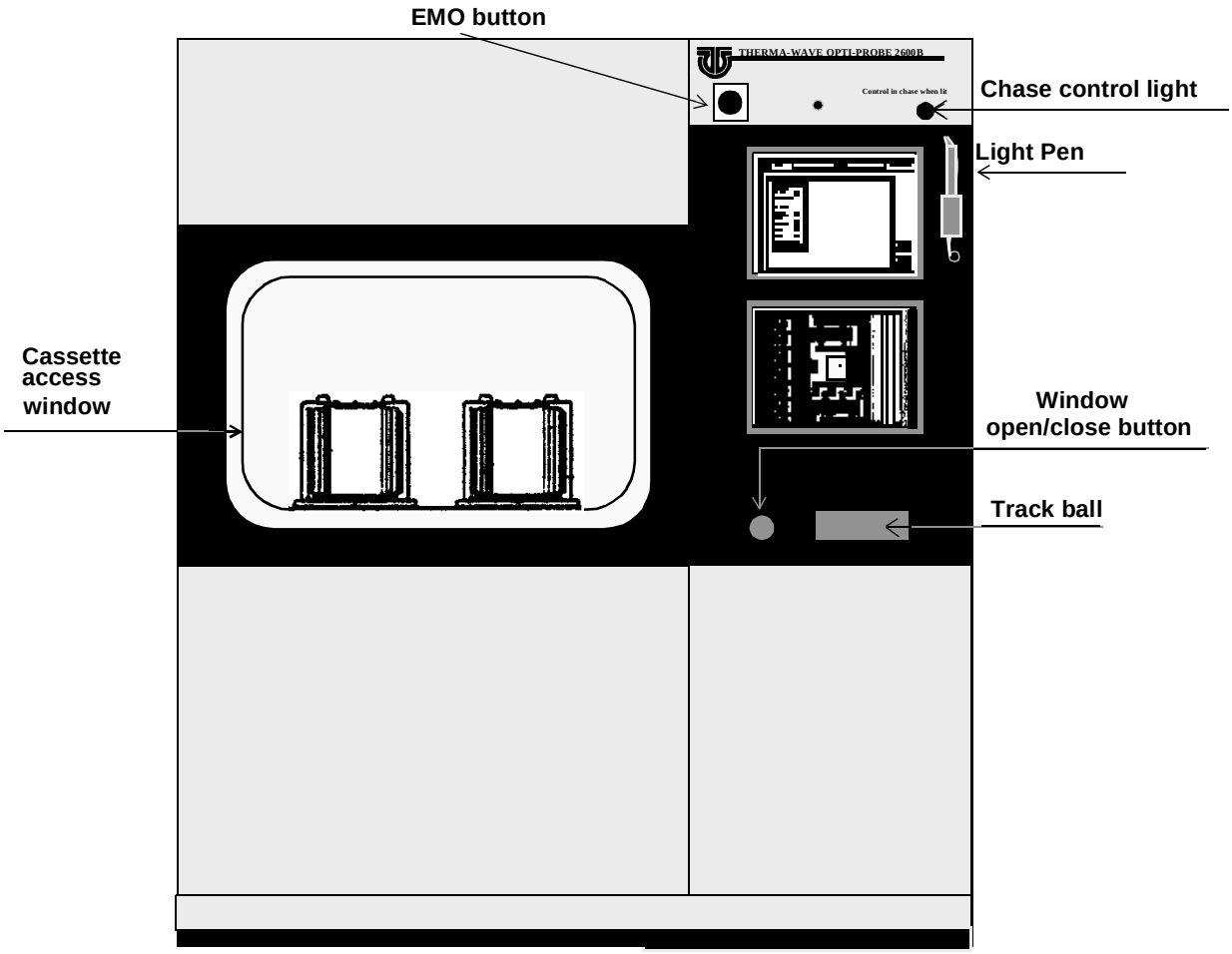
1.1.5 Bulkhead system

The Model 2600B bulkhead system is designed for "through the wall" flush mount clean room installations. This configuration allows you to load wafers and perform measurements without entering the chase area, providing a Class I clean room environment throughout the entire system. In this type of installation, the Operator module is installed inside the fab and the Measurement module is installed inside the chase area. Dual controls allow both normal operation from the Operator module or full control of the system from the Measurement module inside the chase (for maintenance operations). The Operator module includes the user interface components shown in Figure 1.7. For more information on the Measurement module, see Figures 1-26, 1-27, 1-29, and 1-30, later in this section.

Figure 1.7 Model 2600B Operator module



User interface components on a bulkhead system

Video monitors

The Operator module has a TFMS monitor on the top right side of the cabinet and a sample viewing monitor below it, as shown in Figure 1.7. There is also a TFMS monitor and a sample viewing monitor inside the chase area, located on top of the Measurement module.

Light pen

The Operator module has a light pen installed next to the TFMS monitor, as shown in Figure 1.7. There is also a light pen in the chase area, located near the Measurement module's TFMS monitor.

Trackball

The Operator module has a trackball installed below the sample viewing monitor in a retractable draw, as shown in Figure 1.7. You press on the trackball draw to open it. To close the draw, you push it while pressing the lever on its right side. There is also a standard track ball in the chase area, located next to the Measurement module's keyboard.

Cassette access window

To load a cassette of wafers on a bulkhead system, you must open the Operator module's cassette access window (if it isn't already open) by pressing the blue open/close button, shown in Figure 1.7. After opening the cassette access window, you place the cassette of wafers on the cassette flipper. Before initiating a measurement, you can press the blue button again to close the cassette access window. If you do not close the cassette access window, the system automatically closes it after a brief interval. Whenever you open or close the window, you hear a beep until the cassette access window opens or closes completely. After closing the cassette access window and initiating an automated measurement, the cassette platform's rotation system moves the cassette into the wafer handling position. At this point, the robot loads the first wafer for measurements and returns it to the cassette when the measurements are completed. After the system measures all the specified wafers in the cassette, the rotation system returns the cassette to its load/unload position in the cassette access window. To remove the cassette, you must press the blue button to open the cassette access window. After removing the cassette, you should push the blue button once again to close the cassette access window. If you do not close the cassette access window, the system automatically closes it after a brief interval. You should never touch the cassette access window under any circumstances. For information on manually measuring single wafers on a Bulkhead system, see *Load cassette* and *Unload cassette* in Section 2, "Operation Summary."

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EMO buttons

One EMO button is located on the Operator module, above the TFMS monitor, as shown in Figure 1.7. Two EMO buttons are located on the Measurement module, one is at the front, below the TFMS monitor and the other is at the back, below the TFMS monitor, as shown in Appendix A, Safety.

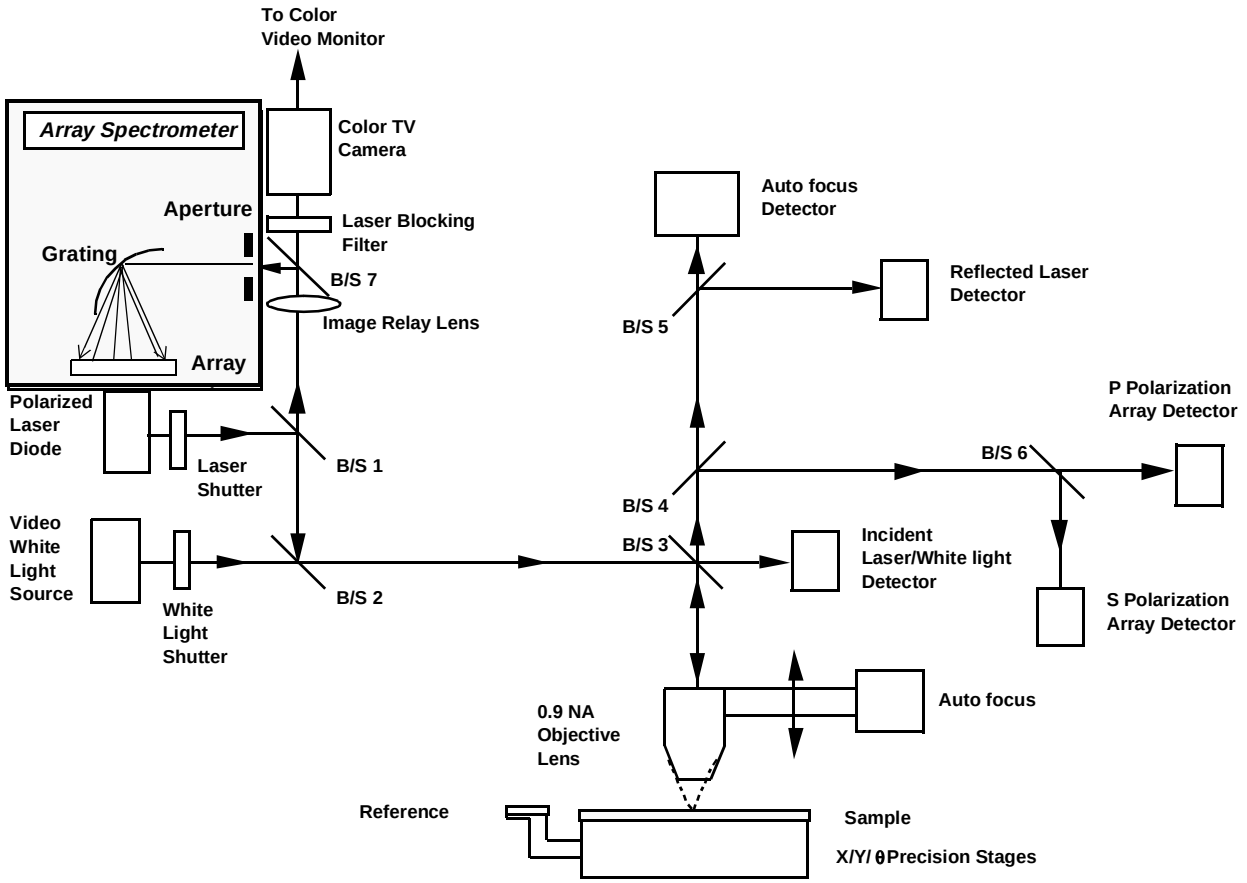
Chase control light

This yellow light goes on when an authorized user is controlling the Opti-Probe from the Measurement module (in the chase area).

1.1.6 Optical system

The optical system is a laser based configuration that measures film thickness on test or product wafers. It is automatically controlled and does not require user adjustment. The system automatically performs the appropriate and necessary tests at preset intervals. Block diagrams of the standard configuration, ellipsometer equipped, and DUV capable systems are shown in Figures 1-8, 1-9, and 1-10, and are described on the following pages. Figure 1.8 shows the optical system for a standard system that does not have an ellipsometer installed. For specific model numbers, see the "Introduction" to this manual.

Figure 1.8 Optical system (standard configuration/ without an ellipsometer)



White light path

The white light source illuminates the sample to enable viewing on a color TV monitor.

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The white light passes through a mechanical shutter, which can close to prevent stray white light from entering the signal detectors. Next, the white light passes through a 50/50 beam splitter, B/S2, and is reflected by another 50/50 beam splitter, B/S3, through a microscope objective lens onto the sample. The white light is reflected from the sample back through the microscope objective lens and is reflected from B/S3 and B/S2. Next, the white light passes through another 50/50 beam splitter, B/S1, a laser blocking filter, and finally an image relay lens that forms an image of the sample on the color TV camera. The sample appears in color on the video monitor, taking advantage of the visual color cues from the sample. The white light system is utilized by Opti-Probe users to view wafers. It is also used by the system's vision processor (VP) [on systems with a VP installed] and spectrometer (described later in this section).

Laser path

The laser source is a linearly polarized 675 nm wavelength diode laser. The laser beam is reflected from 50/50 beam splitters (B/S1, B/S2, B/S3) through the microscope objective lens. This lens focuses the beam onto the sample. Part of the incident laser beam passes through B/S3 to an incident laser power detector. The incident laser power detector normalizes any fluctuations in laser power.

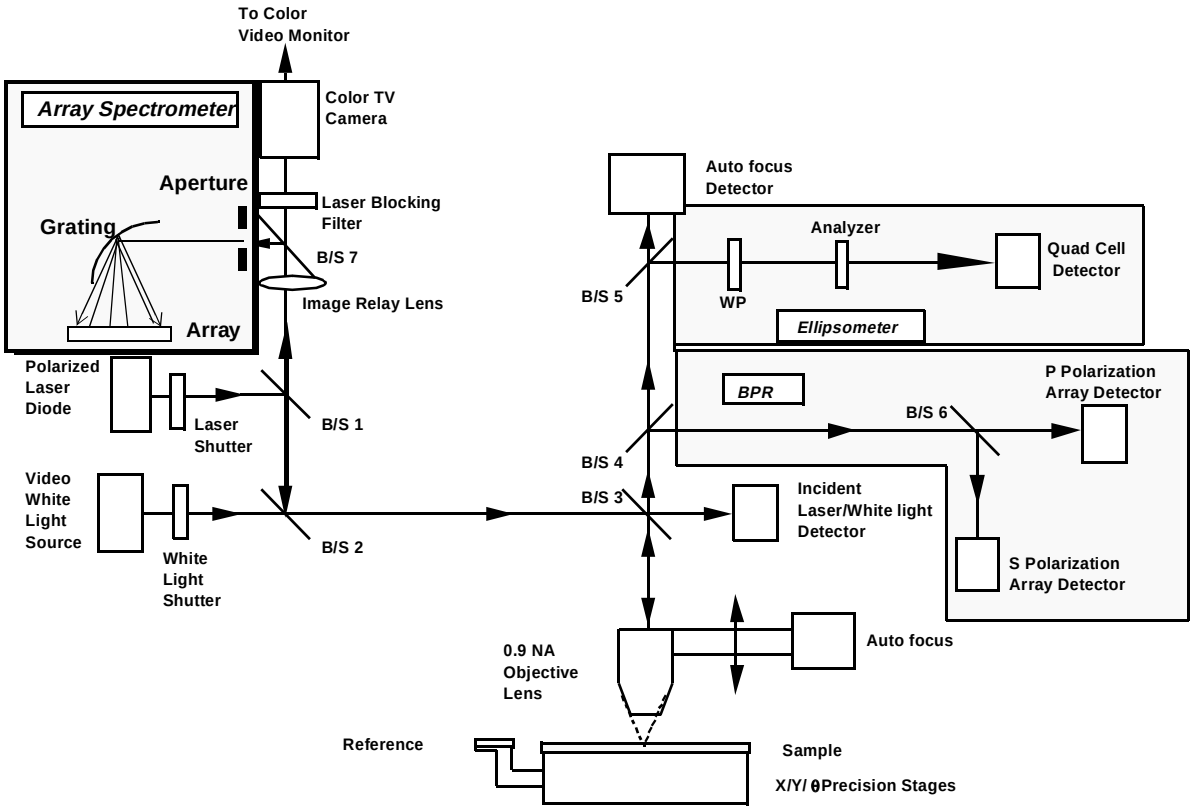
The laser beam is reflected from the sample surface back through the microscope objective lens and B/S3 towards array and auto focus detectors. B/S4 splits the beam and reflects part of it towards B/S6. B/S6 splits the beam towards two low noise, wide dynamic range, linear photo-diode array detectors. These two diode arrays record s and p polarization dependent interference intensity profiles that correspond to angles of incidence on the sample ranging from 0 to 64 degrees.

The reflected laser beam also passes through B/S4 and is split by B/S5 toward a third detector. On systems without an ellipsometer, this detector is the reflected laser power detector, as shown in Figure 1.8. This is a single Si photo-diode that detects a signal proportional to the entire reflected beam intensity.

Ellipsometer

For systems with an ellipsometer installed, a quarter-wave plate (WP), a linear polarizer (or analyzer), and a four-quadrant detector (quad cell) replaces the reflected laser power detector, as shown in Figure 1.9. These components measure the amplitudes and phase difference of the s and p reflectivities. For ellipsometer system model numbers, see the "Introduction" to this manual.

Figure 1.9 Optical system (ellipsometer installed)



DUV configuration

DUV systems use both deuterium and tungsten bulbs as UV and Visible light sources, respectively. The combination of these two light sources allows you to perform reflectivity measurements over the continuous full spectral range. A monochrometer selects the appropriate wavelength for measurements in the UV range. To perform a UV measurement, the system uses a separate lens with its own focusing system, and the stage physically moves the sample under this lens. There are I-UV and R-UV detectors mounted on the optics plate, which detect the incident and reflected signals. To vary the effective beam spot striking the

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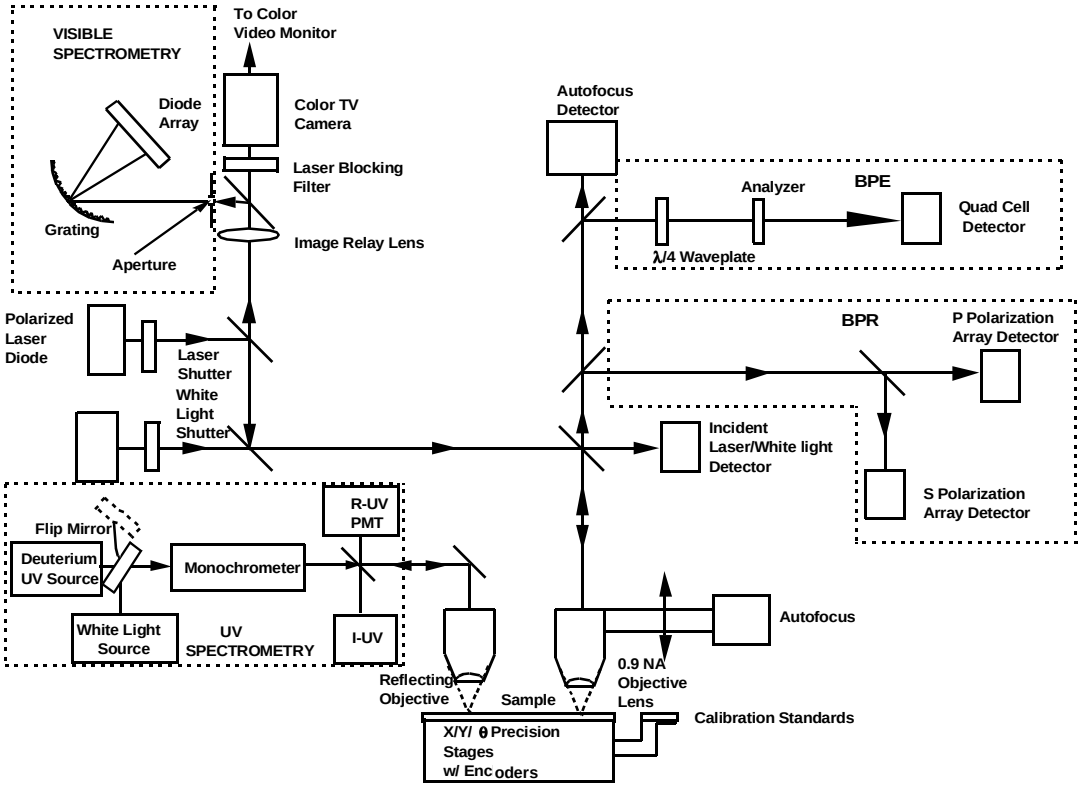
sample, a switch moves an aperture in or out of the beam path. For the small aperture, this beam spot is 15µm, and for the large aperture it is 40µm

Figure 1.10 is a block diagram of the DUV configuration.

Figure 1.10 Optical system (DUV configuration)



Auto focus system

Part of the reflected laser beam passes through B/S5 to the auto focus detector. A high speed, high precision auto focus servo system automatically focuses the microscope objective lens. The auto focus detector senses the reflected laser collimation that drives a coarse and fine focus servo system and maintains a precise focus. The fine focus servo system utilizes piezoelectric devices that achieve a vertical positioning resolution of 10 nm and a bandwidth >100 Hz. The high magnification lens (see Microscope, below) requires precise focusing to ensure repeatable magnification at the s- and p-polarization detectors. When the focus servo system locks on a sample positioned for a measurement, it maintains focus continually on the sample.

Microscope

The microscope utilizes a microscope objective lens for viewing the sample. The high magnification lens is an 80x 0.9 numerical aperture (NA) microscope objective lens that focuses the laser beam to a 0.9 µm diameter spot on the sample. The system uses this lens to perform measurements. The low magnification lens is a 5x 0.15 NA microscope objective lens that the system uses for wafer positioning and mask alignment. The system uses both lenses to perform pattern recognition operations on VP equipped machines.

Spectrometer

The beam splitter located in front of the color TV camera (B/S 7) passes light to the array spectrometer. The lens that images the sample onto the TV camera also forms an image of the sample surface on the spectrometer aperture. This aperture determines the measurement area seen by the spectrometer (approximately 13µm in diameter). The array spectrometer uses a holographic diffraction grating to select the wavelength. Light passes through the aperture to the grating and is dispersed over the length of a diode array. The spectrum is composed of about 150 points. This continuous range of wavelengths allows the accurate measurement of film reflectivity. The array spectrometer's optics and high detection sensitivity allow the small 13µm measurement area, which is very useful for measuring patterned wafers.

1.1.7 Computer system

The Opti-Probe computer system is mounted in the electronics chassis, which is located inside the front cabinet, as shown in Figure 1-2. It controls and monitors all system activity. You communicate with the computer system through the user interface components, described earlier in this section. The computer system includes the following components:

- CPU (central processing unit)
- Side interface panel
- Rear interface panel
- SECS board

CPU

The CPU is an 80486 DX2 66 MHz or faster microprocessor with 16 MB of RAM that is located inside the Opti-Probe's front cabinet. It includes a battery backup for the CMOS memory, a real time clock, and calendar. The parallel and serial ports are disabled and are replaced by the ports on the Digital I/O Controller Board, described below. Authorized trained users can restart the CPU by pressing the Reset button inside the front cabinet.

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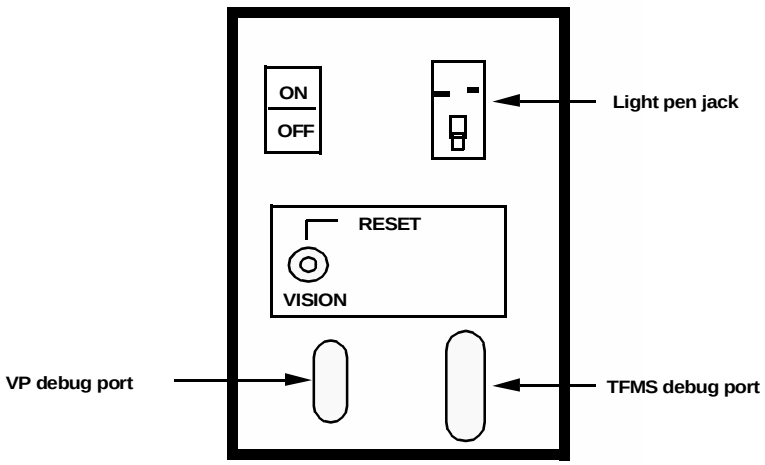
Side interface panel

The Side interface panel, shown in Figure 1.11, is located on the left side of the Opti-Probe. It includes an ON/OFF switch, light pen jack, and TFMS debug port. On VP equipped machines, it also includes a VP reset button and a VP debug port. Only Therma-Wave personnel use the debug ports.

Figure 1.11 Side interface panel



On/Off switch

In a typical operating environment, the Opti-Probe is always powered up and running. You may, however, have occasion to turn the power on and boot up the system. To power up the system, press the blue rocker switch to the ON position. The system automatically initializes in about 3-4 minutes, and then the Main Menu window appears on the TFMS monitor. For more information on the Main Menu window and the TFMS software, see your "Getting Started" manual.

For (non-emergency) troubleshooting, you may have to turn off the power and reboot the system. You can do this by following these steps:

1. Unload any loaded wafer.
2. Press the blue rocker switch to the OFF position.
3. Wait about one minute for the hard disk to spin down.
4. Press the blue rocker switch to the ON position.

Light pen jack

The light pen jack is an RJ-11 phone jack that connects the light pen to the system.

VP Reset button (VP systems only)

The VP Reset button resets the VP. You should only press this button if you are unable to correct a VP communication failure using the Initialize VP function. For more information on this function, see Section 4.

TFMS and VP debug ports

Only Therma-Wave personnel use the debug ports.

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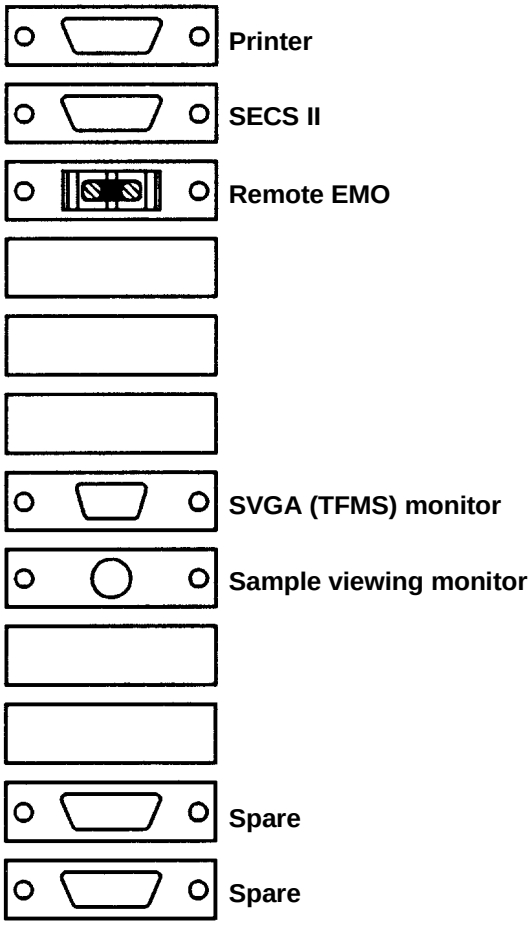
Rear interface panel

The Rear interface panel is located at the back of the Opti-Probe, as shown in Figures 1.12 and 1.13. It has ports for the printer, TFMS monitor, sample viewing monitor, and SECS link (if a SEMI Equipment Communication Standard system is installed). It also has a remote EMO switch and several spare ports.

Figure 1.12 Rear interface panel



Printer port

You can connect the Opti-Probe's standard printer to the printer port.

SECS II port (SECS equipped systems only)

The SECS II port is a serial COM port, that connects the Opti-Probe to a Host computer.

Remote EMO port

You can use the Remote EMO port as an alternate EMO switch for a bulkhead installation or in a standard installation to meet your facility's safety requirements.

SVGA monitor port

You connect the TFMS monitor to the system through this port.

Sample viewing monitor port

You connect the sample viewing monitor to the system through this port.

SECS board (SECS equipped systems only)

This board provides the SECS connector and related electronics that are required for SECS II communications.

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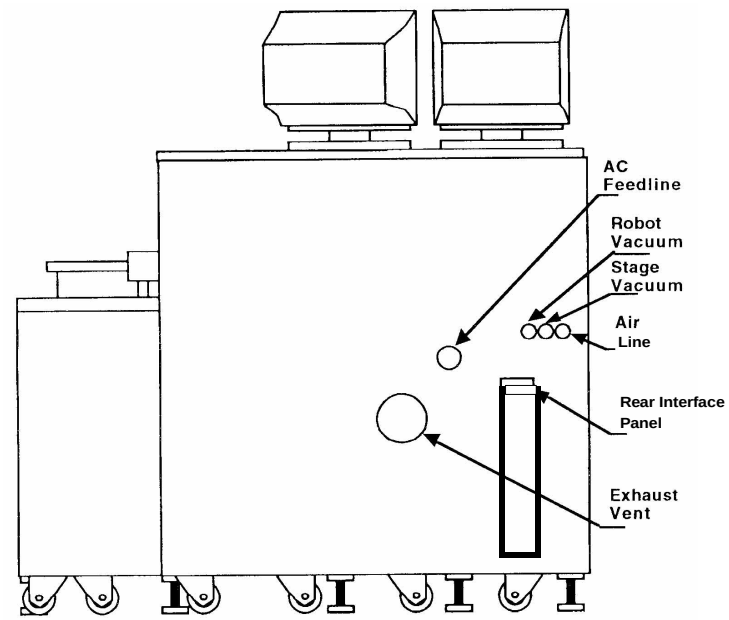
1.1.8 Pneumatic system

The pneumatic system is connected at the back of the Opti-Probe. It consists of vacuum lines that supply vacuum to the stage and robot, an air line that supplies air to the isolators, and an exhaust vent that exhausts heated air away from the system. The external connectors are shown in Figure 1.13. These connect to facilities that are described later in this section under "Facility requirements."

Figure 1.13 Pneumatic system



Air line

Shock vibration isolators reduce the transmission of system and facility vibration to the sensitive optical components. These isolators contain pressurized and filtered dry air that lifts the optics plate so that it floats above the system frame. Isolator pressure is controlled by regulators on the pneumatic panel inside the main cabinet. The height of each isolator is controlled by an adjustable position needle valve.

Vacuum lines

The robot and measurement stage use separate vacuum lines. Each vacuum line is routed through a solenoid valve and contains vacuum switches that monitor the status of system

vacuum and the presence of a wafer (on the robot or the stage). A vacuum reservoir is incorporated in the robot vacuum line to maintain vacuum in case the facility vacuum fluctuates or fails.

Exhaust vent

The electronics chassis has a built-in fan that cools the system as required. The fan blows the air out of the system through a 4-inch diameter exhaust vent. The exhausted air should be directed into an exhaust duct out of the wafer fabrication area into the chase.

1.1.9 Vision processor system (optional)

The optional vision processor (VP) includes a Cognex board, located inside the Opti-Probe's front door, and pattern recognition software. The board has a 68020-based processor and 4 MB of RAM. The VP files are stored on the E partition of the hard disk. The VP system performs pattern recognition tasks, including wafer alignment and measurement site alignment. For VP system model numbers, see the "Introduction" to this manual.

1.2 FACILITY REQUIREMENTS

The installation site must meet specific facility requirements in the following areas:

- Exhaust
- Vacuum supply
- Air supply

Exhaust requirements

The internal cooling fan must be ventilated through the exhaust vent on the back of the Opti-Probe. A 4-inch diameter hose directs the exhaust air out of the wafer fabrication area into the chase.

Vacuum supply requirements

To operate the robot and the vacuum chuck on the stage, the vacuum supply must provide at least 22 inches of Hg.

Air supply requirements

To operate the vibration isolation system, dry, pressurized N_2 or air at 60 psi is required.

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1.3 POWER REQUIREMENTS

The installation site must meet specific power requirements in the following areas:

- Input power
- Voltage limits
- Frequency limits
- Harmonic content
- Power service
- Grounding

Input power

The input power must be three-wire, single-phase, 100-120 Vac or 200-240 Vac root mean square (RMS). The standard configuration is set up for 120 Vac operation. The third wire must be an equipment grounding conductor and the power circuit must supply 15 amps continuously. The Opti-Probe can also be hard-wired to a facility breaker box.

Voltage limits

The steady-state voltage, measured while the Opti-Probe is being used, must be maintained within ± 10 percent of the nominal rated voltage. A transient voltage condition must not exceed 20 percent of nominal and must return to the steady-state tolerance of ± 10 percent within 500 microseconds.

Frequency limits

The line frequency must be maintained at 50 or 60 Hz, ± 2 Hz.

Harmonic content

The maximum total harmonic content of the voltage waveforms on the equipment feeder must not exceed 5 percent while the system is operating.

Power service

To ensure maximum system reliability, the Opti-Probe's power circuit should not be used to power any other equipment. Transient-producing devices, such as induction motors, heaters,

etc. should be powered from separate feeders to eliminate potential sources of noise interference.

Any system failures that are caused by transients void the warranty and service contract agreements. If problems are known to exist, an isolation transformer may be required.

Grounding

All systems have an equipment ground that must be tied into a single main ground. This equipment ground is a dedicated ground, not a neutral, and must be carried back to a service ground or a suitable building ground. The ground should not be shared with other equipment between the power supply and the service ground point. Conduit must not be used as the only means of grounding.

Power problem areas

All reasonable effort has been made to ensure satisfactory operation from the ac power supplied by most power companies. There are many outside variables over which neither the power company nor Therma-Wave has control. These variables can cause the following types of power malfunction:

- Power outages

  These include short duration dips in voltage as well as prolonged outages. If the frequency of such power failures is not acceptable for your operation, it may be necessary to install a standby power system or Un-interruptible Power Supply (UPS) at additional cost.

- Transient electrical noise superimposed on facility power lines

  This problem can be caused by external power lines that produce a transient within or adjacent to your facilities. Another source of transients is lightning.

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1.4 GENERAL SPECIFICATIONS

Electrical power	100-200 Vac or 200-240 Vac 50 or 60 Hz ± 2 Hz 15 Amperes (A) breaker 120 Vac, 15 A, 60 Hz is standard for U.S.A.
10 percent tolerance	50 / 60 Hz, 20 A (Max)
Vacuum requirements	20-24" Hg, .6 SCFM min(for each of the 2 independent lines)
Air or N_2, clean, dry	70 psi, 100 psi maximum filtered to 0.5 µm H_2 O vapor < 5 % oil free, 0.6 SCFM
Exhaust vent and fitting	4" (100mm) diameter, flexible hose 350 SCFM mini
Target room temperature	20° C ± 2° C
Temperature variation over 24 hours	Target room temperature ± 1° C
Humidity, room	30 percent to 70 percent maximum change in 1 hour: ±2 %
Floor vibration	< 2 mils peak amplitude at > 10 Hz < 0.5 mil peak amplitude at < 10 Hz
Electrical receptacle	NEMA 5-20R for 100-120 Vac installations NEMA 6-20R for 200-240 Vac installations
Vacuum, air fittings	1 / 8" (3.175 mm) ID hose barb (2 each)
Vacuum capacity	22" to 24" (50.8 to 61 cm), 4 ft^3 / hr
Electro-static discharge	ESD - 5KV max (ionizer required beyond this limit
Clean room	Class 100 or better
Safety compliance	Nat'l Elec. Code, UL approved, applicable CDRH regulations, IBM corporate safety stds, S2-93
Options	SECS II, Signal tower, SMIF indexer, ESD ionizer, CE96

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2

OPERATION SUMMARY

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This section describes all the Operator level windows, menus, buttons and functions. All users can access the Operator level. At this level of TFMS, you open a job file, and then load and designate your cassette(s) of wafers for measurements. The Opti-Probe automatically measures the wafer(s) in the cassette(s). You can also run several diagnostic functions, view previously saved data, including SPC charts, and perform other functions.

Before reading this section, you should be familiar with the Opti-Probe's TFMS graphical user interface software and know how to use the light pen to perform basic Opti-Probe tasks. This information is described in your "Getting Started" manual.

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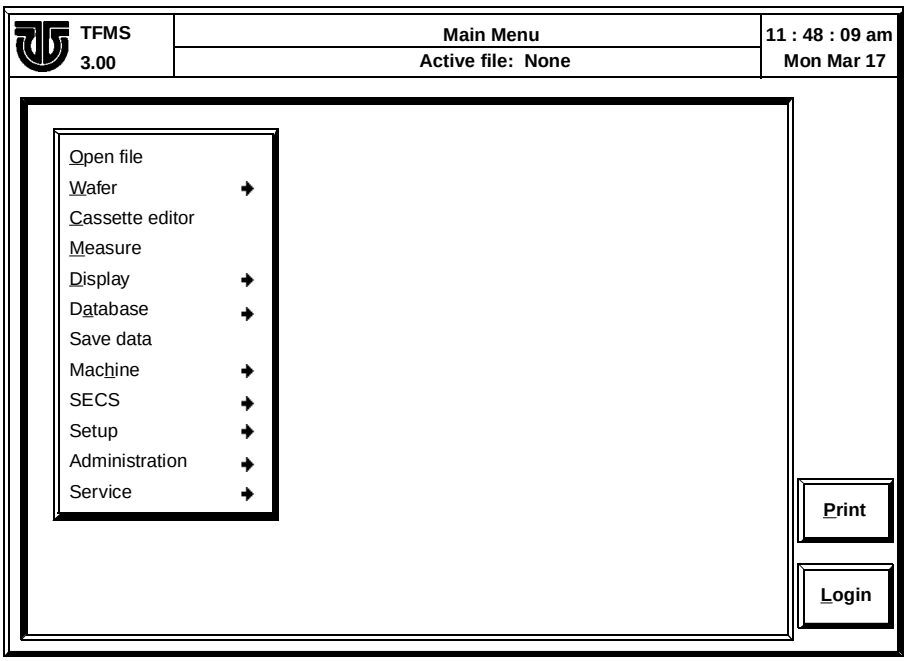
2.1 MAIN MENU WINDOW

You begin each session at the Operator level in the Main Menu window. You can always return to this window by selecting the *Exit* button(s) until the Main Menu window appears (for an example, see the *Exit* button in Figure 2.3).

Figure 2.1 Main Menu window (Operator level)



2.2 PRINT BUTTON

The *Print* button appears in the lower right margin of the Main Menu window as shown in Figure 2.1. The *Print* button also appears in the right margin of most Opti-Probe windows. When you select a *Print* button, the printer prints a copy of the current screen display. Sometimes, dialog boxes and pop-up menus appear on the screen that also contain *Print* buttons. When this happens, the *Print* button in the dialog box or pop-up menu is selectable instead of the *Print* button in the right margin.

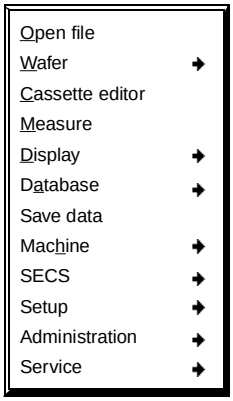
2.3 LOGIN BUTTON

The *Login* button appears below the *Print* button, in the lower right margin of the Main Menu window as shown in Figure 2.1. Only authorized users should select the *Login* button. If you select the *Login* button, a keyboard window appears requesting a User ID. If you do not have a User ID, select the *Exit* button in the keyboard window's right margin to return to the Main Menu window. For more information on the login procedure, see your "Getting Started" manual.

2.4 MAIN MENU

Operator level users can select *Open file*, *Wafer*, *Cassette editor*, *Measure*, *Display*, *Database*, *Save data* (when activated), *Machine*, and *SECS* (when installed) in the Main menu. The examples in this section show menus for systems that do not have SECS installed. Selectable Main menu options appear in white with one underlined character, while non-selectable functions appear in blue with no underlined character. You can use these underlined characters to enter keyboard commands if the light pen is out of service. For instructions on using keyboard commands, see your "Getting Started" manual.

Figure 2.2 Main menu (Operator level)



2.5 OPEN FILE

When you select *Open file* in the Main menu, the Open window appears, as shown in Figure 2.3. A list of directories appears in the Directories field with the first directory highlighted in light green. The Sub-Directories and Job Files fields appear next to the Directories field. You also see a *Chain* button in the window's right margin, and two small arrows pointing at boxes located on the top and bottom

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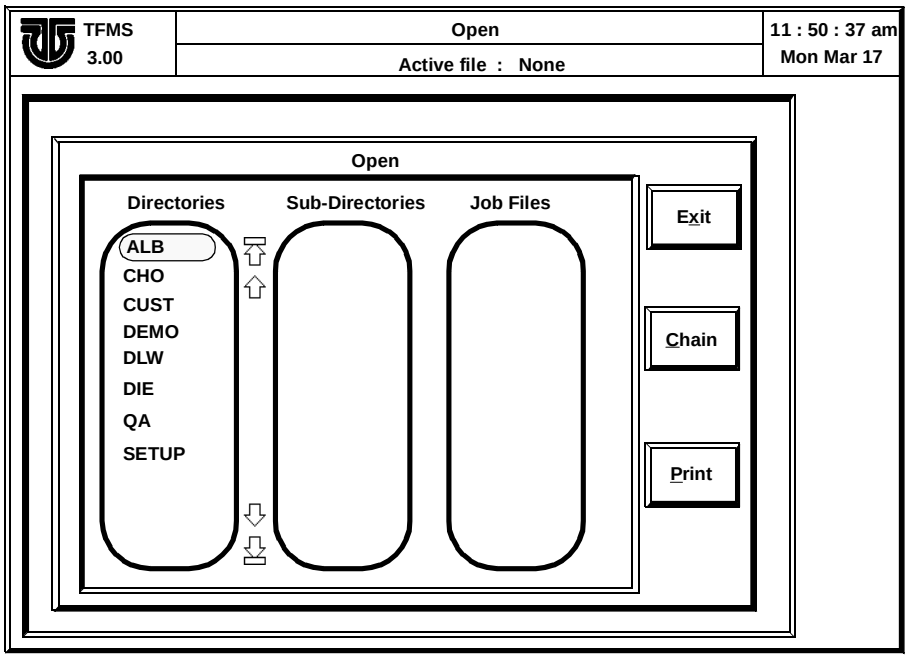
right side of the Directories field. These are scrolling arrows. You use these scrolling arrows to move through an extended list of directories, sub-directories or job files. For a complete description of the scrolling arrows, see "Scrollable list windows" in your "Getting Started" manual.

Figure 2.3 Open window



The Opti-Probe can store any number of directories, sub-directories and job files, limited only by the storage capacity on the hard disk.

After you make a selection with the light pen, it turns dark green. When you select a directory, a list of sub-directories appears. When you select a sub-directory, a list of job files appears. When you select a job file, the screen blanks briefly while the system loads the necessary files, and then the job file name appears as the Active file in the Status area. The active job file specifies all setup parameters related to a

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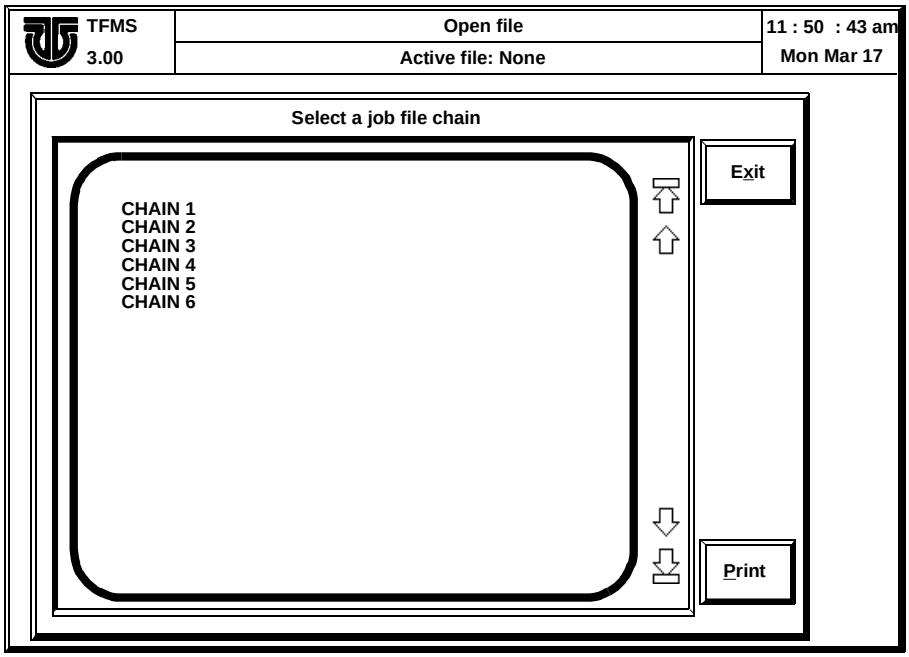
measurement. For step-by-step instructions on selecting job files, see your "Getting Started" manual.

If the recipe partition on the Opti-Probe hard disk is more than 90% full, a dialog box appears with a message. If you see this message, tell your System Manager that it is time to delete old job files and measurement data. When the recipe partition is about 95% full, you cannot save data or create new job files; the exact figure depends on your hard drive configuration. Select *Ok* to close the dialog box and return to the Main Menu window.

2.5.1 Chain button

Job file chains allow you to perform time efficient wafer measurements using multiple recipes from different job files. The system automatically runs the desired job files in the specified order, measuring the selected wafers in their slot sequence. Engineer or higher level users set up job file chains, which are saved in the Job file chain library and secured by ownership like individual job files. When you select the *Chain* button in the Open window, the Select a job file chain window appears with a list of all the chain library entries, as shown in the example in Figure 2.4. When you select one of these entries, it becomes the active job file chain, which is indicated in the Status area. If the active job file chain is configured to display the Chain editor at runtime, you can temporarily override the current chain setup before the wafer measurement process, as described next. For a complete description of the job file chain setup, see Section 4, "Engineer Functions."

Figure 2.4 Select a job file chain window



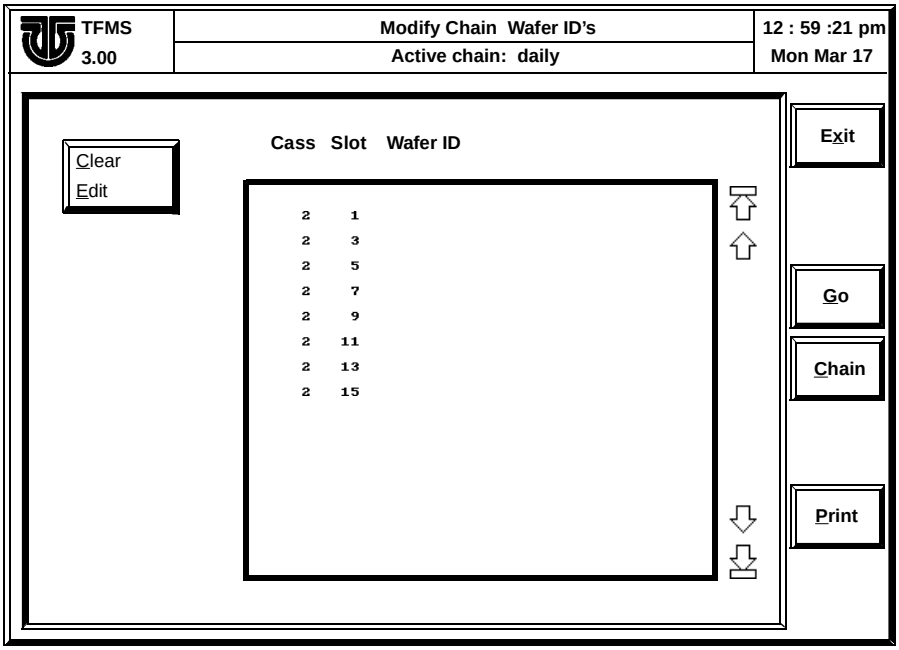
2.5.2 Chain editor

If the active job file chain specifies the appearance of the Chain editor, it appears before the job file chain measurement begins. Sometimes, the Process Information window appears before the Chain editor window. For more information on the Process Information window, see *Measure* , later in this section. For a complete description of the Process Information window, refer to your "Getting Started Manual."

There are two Chain editor windows, the Modify Chain Wafer ID's window and the Modify Chain/Slot Usage window. The example in Figure 2.5 shows the Modify Chain Wafer ID's window. In this window, when you select a cassette/slot number entry and then the *Edit* option, you can enter a Wafer ID or change an existing one. When you select a cassette/slot number with a Wafer ID, and then the *Clear* option, the system deletes the Wafer ID. When you select the *Chain* button,

the Modify Chain/Slot Usage window appears, as shown in the example in Figure 2.6. When you select the *Go* button, the system begins the measurement process.

Figure 2.5 Modify Chain Wafer ID's window



You can enable/disable usage of a specific job file/cassette/wafer sequence in the Modify Chain Cassette/Slot Usage window. To disable a job file sequence, you select an entry in this window, and then the *Disable* option. The sequence, cassette, and slot number entries for that job file sequence disappear. If you select that job file entry again, and then the *Enable* option, the deleted entries re-appear and the job file sequence is enabled. If you select the *Wafer Id* button, the Modify Chain Wafer ID's window appears. When you select the *Go* button, the system begins the measurement process.

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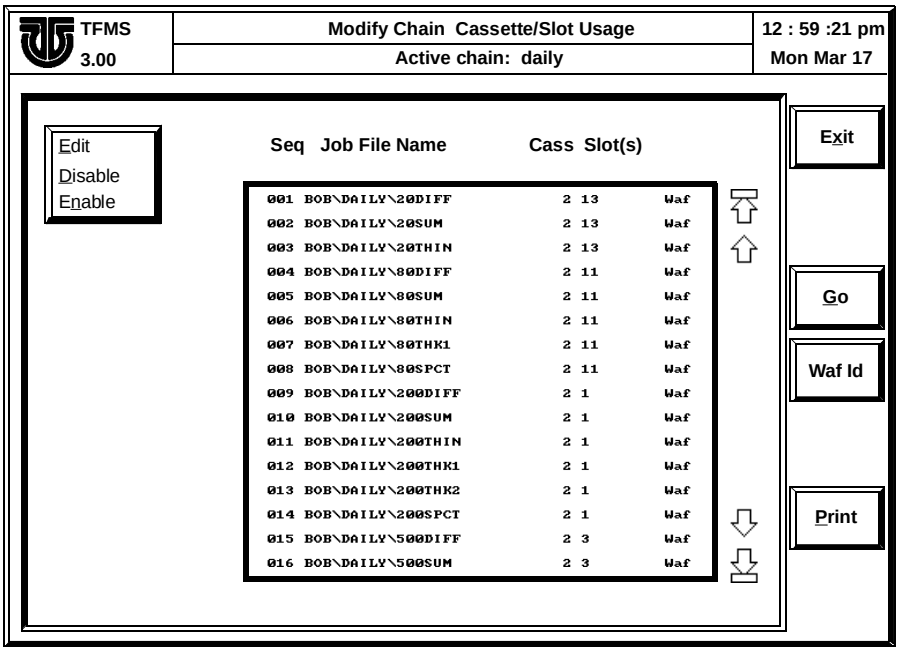
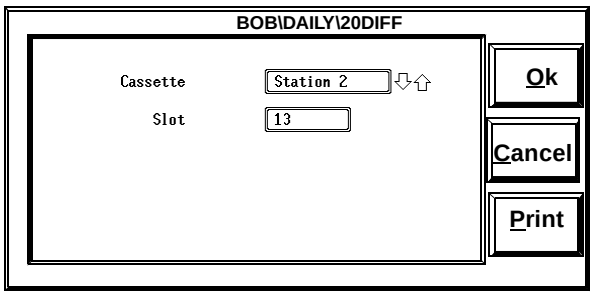
Figure 2.6 Modify Cassette/Slot Usage window



If you select an entry, and then the *Edit* option, the Job file station and slot window appears, as shown in Figure 2.7. In this window you can modify the cassette station and slot number for the selected job file in the chain sequence.

Figure 2.7 Job file station and slot window

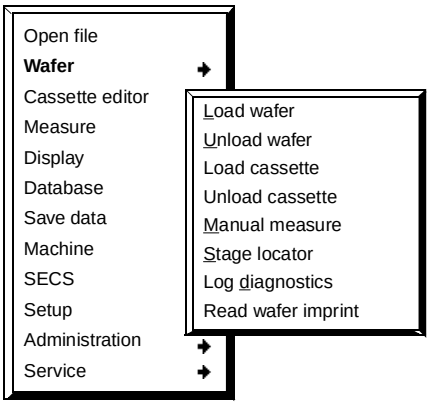


2.6 WAFER

When you select *Wafer* in the Main menu, the Wafer menu appears, as shown in Figure 2.8. This menu controls the loading, unloading, manual stage positioning, measurement, and wafer imprint reading of single wafers. This means that you can override some of the automated job file parameters when you'd like to load a single wafer, examine it using the Stage locator facility, and perform repeated measurements on the same wafer before unloading it. This menu also controls the manual loading and unloading of cassettes for bulkhead systems and wafer imprint reading for systems equipped with this optional feature. In addition you can use the *Log diagnostics* option if you're having problems with a measurement and you want to send the raw measurement data to Therma-Wave.

The Load cassette and Unload cassette options are only selectable on bulkhead and SMIF Indexer systems. The Read wafer imprint option is only selectable on Wafer Imprint Reader (WIR) equipped systems.

Figure 2.8 Wafer menu



2.6.1 Load wafer

When you select *Wafer/Load wafer*, the system moves the desired wafer from a cassette to the measurement stage without initiating a measurement sequence. A dialog box appears asking you to enter a cassette station and slot number for the wafer you want to load. If a wafer is already on the measurement stage, a dialog box appears asking if you want to unload it. After you load a wafer, do not remove the cassette from the station platform until the system unloads the wafer. For more information on loading wafers, see "Performing a manual single wafer measurement" in your "Getting Started" manual.

Below each cassette station are red and green indicator lights. The green light indicates that it is Ok to unload a cassette of wafers or that the cassette station is empty and ready to be loaded. The red light indicates that it is not Ok to unload a cassette of wafers because a wafer remains on the measurement stage. The red light comes on as soon as the robot begins the load operation and stays on until the wafer is unloaded to the source cassette and the robot returns to the neutral position.

2.6.2 Unload wafer

When you select *Wafer*/*UnLoad wafer,* the system removes the wafer from the measurement stage, and returns it to its original slot and cassette.

2.6.3 Load cassette (Bulkhead systems only)

This option enables single cassette loading on Bulkhead systems. It allows an operator to manually load the desired cassette from the Bulkhead system's cassette access window to the measurement module without initiating a measurement.

2.6.4 Unload cassette (Bulkhead systems only)

This option enables single cassette unloading. It allows an operator to manually unload the desired cassette from the Bulkhead system's measurement module and return it to the cassette access window.

Before you select the Load cassette, and Unload cassette options on a Bulkhead system, you should know how to operate the Cassette access window on the Model 2600B Operator module, as described in Section 1, "System Description."

Do not select Load cassette or Unload cassette if a wafer is on the measurement stage.

2.6.5 Load cassette (SMIF Indexer models only)

SMIF Indexer systems are equipped with special enclosures called pods. The pod maintains a clean environment for transporting wafers. You must place the pod on the Indexer with the front of the cassette facing the Opti-Probe. If you place the

pod in any other direction, it does not seat properly on the Indexer platform and the system cannot sense its presence.

When you select Load cassette on a SMIF Indexer system, the system latches the pod to the Indexer preventing its removal, unlocks the pod base plate from the pod, and moves the Indexer elevator to the stage position so the robot can load wafers. While lowering the elevator, the system scans the cassette, creating a cassette wafer map that detects cross slotted, loaded, and unloaded wafers. If the wafer map does not match the selected wafers in the active job file, a message appears that says you can change the job file's wafer string. Wafer mapping increases throughput by preventing wafer loading attempts from empty cassette slots. Detecting cross slotted wafers prevents the cassette from falling when the robot retrieves them, preventing damage and possible loss of the wafers.

2.6.6 Unload Cassette (SMIF Indexer models only)

When you select this option on a SMIF Indexer system, the system raises the Indexer elevator to the Home position (top position), locks the pod base plate into place with the pod cover, and unlatches the pod from the Indexer so you can remove it from the Indexer platform.

2.6.7 Manual measure

Measures the wafer on the measurement stage using the active job file's measurement setup. The wafer remains on the measurement stage after the measurement (rather than unloading). If you select *Manual measure* and there is no wafer on the measurement stage, a dialog box appears informing you of this. For more information on using this function, see "Performing a manual single wafer measurement" in your "Getting Started" manual.

2.6.8 Stage locator

This option allows you to position the stages, displaying any section of the wafer on the sample viewing monitor, and placing it under the laser spot. When you select *Wafer*/*Stage locator*, the Stage locator window appears, as shown in Figure 2.9.

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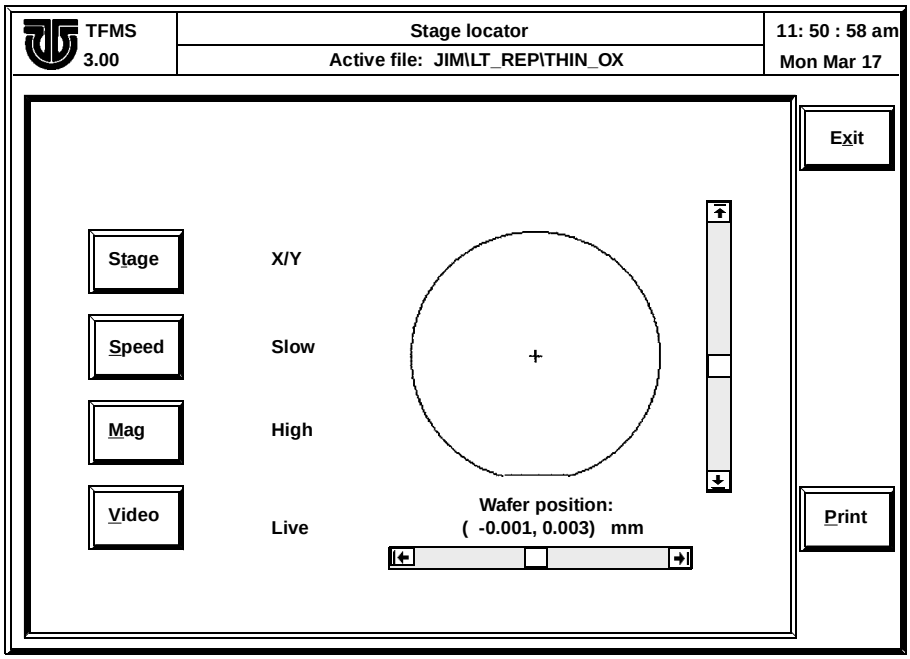
Figure 2.9 Stage locator window



You can position the stages by rolling the trackball, or by selecting a section of the Stage locator window's scroll bars with the light pen. Following are descriptions of these and other Stage locator features.

Wafer shape

Displays the current location of the laser spot on the sample (represented by the red cross-hair). The position of the flat is fixed and does not depend on the orientation of the wafer on the stage. The wafer shape in the window represents a flat even if the job file is set up to measure a notched wafer.

Stage button

Changes the stage coordinate(s) controlled by the trackball. The options are *X/Y* and *Theta*. The active coordinate(s) appear(s) next to the button. When you select *X/Y,* horizontal trackball motion causes the sample to move in the horizontal or X direction on the sample viewing monitor, while vertical trackball motion causes the sample to move in the vertical or Y direction. When you select *Theta*, horizontal trackball motion causes the sample to rotate, while vertical trackball motion has no effect.

Speed button

Selects the trackball speed. The current speed (fast or slow) appears next to the button. When you select fast speed, trackball motion moves the stages more quickly than when you select slow speed. To change the trackball speed, select the *Speed* button with the light pen.

Mag button

Selects the viewing magnification. The current magnification (high or low) appears next to the button. In high magnification, the field of view on the sample viewing monitor is ~100 µm (horizontal) x ~80 µm (vertical). In low magnification, the field of view is 16x as large as in high magnification. In most cases, when you view the sample in high magnification, you'll use the slow trackball speed, and in low magnification you'll use the fast trackball speed. To change magnification, select the *Mag* button with the light pen. The color of the button briefly changes to dark green until the autofocus focuses on the sample.

Video button

Provides three video display options for the sample viewing monitor: *Live* (color), *VP* (Black and White with video box and crosshair), and *Meas area* (Black and White with the spatial averaging and spectrometer regions outlined). The *Meas area* option displays the measurement area on the wafer augmented 2.5µm in each direction based on spatial averaging parameters, and scales the measurement area to the magnification. In addition, this function also displays the spot size area for spectrometer measurements (40µm for the twelve color spectrometer and 12µm for the array spectrometer). The *VP* option is non-functional for Models without a vision processor (VP) installed.

Wafer position, Wafer angle

‘Displays the wafer coordinate(s) specified by the *Stage* button. The X and Y coordinates (wafer position) are displayed in millimeters, while the Theta coordinate (wafer angle) is displayed in degrees.

Trackball

The trackball is located on the left side of the keyboard cover and is only activated when a Stage locator appears in a window. If you'd like to move the laser spot in a specific direction relative to the pattern you see on the sample viewing monitor, roll the trackball by moving your hand over it in the desired direction (e.g., up, down, left, right).

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Scroll bars

You can also position the laser spot on the sample with the light pen, using the scroll bars on the right and bottom sides of the wafer shape. The horizontal scroll bar below the wafer shape controls horizontal (X) motion, while the vertical scroll bar on the right side of the wafer shape controls vertical (Y) motion.

When you use the scroll bars, the stages move in multiples of the die size, specified in the Wafer control parameters window. For more information on entering the die size, see Section 3, "Engineer Functions." If a die size is not specified (die pitch x=die pitch y=0), the system uses a 1.5 mm default stepping size. When you select one of the scroll bar arrows with the light pen, the stages move so that the laser spot moves one die size from its current location in the direction of the arrow. The color of the arrow briefly changes to dark green while the stage is moving.

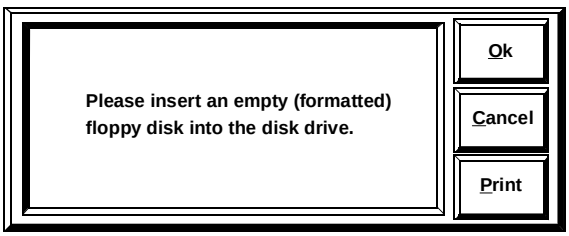
When you select a section of the scroll bar with the light pen, the stages move along the indicated axis so that the laser spot is near the selected coordinate location. The stage moves an integer number times the die size. The color of the scroll bar briefly changes to dark green while the stage is moving. The button in each scroll bar indicates the current location along with the corresponding coordinate.

2.6.9 Log diagnostics

If you’re having problems with a measurement, you can copy the diagnostic (raw measurement) data to a floppy disk and send it to Therma-Wave for analysis and recommendations. You can only perform this operation after a manual measurement.

After you perform a manual measurement and select *Wafer*/*Log diagnostics* , a dialog box appears asking you to insert an empty, formatted, floppy disk in the disk drive, as shown in Figure 2.10.

Figure 2.10 Insert floppy disk dialog box



You follow these instructions and insert a DOS formatted floppy disk in the floppy disk drive. If you insert a floppy disk that is not empty, another dialog box appears asking if it is Ok to erase all the files on the floppy. If you see this message, and want to erase the files on the floppy, select *Ok* in the dialog box. At this point, a dialog box appears that says: *Clearing floppy disk...Please wait,* and then another dialog box says: *Transfer in progress...Please wait.* During the transfer process, the log diagnostic file ID's appear in the Status line as the system copies each file to the floppy disk.

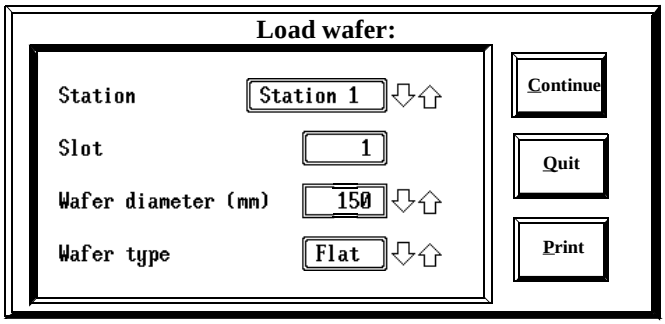
The system copies a detailed measurement data for each measurement point. If a measurement contains a large number of measurement points and more than one floppy disk is required, a dialog box appears asking you to remove one floppy and insert another. When the system completes the transfer, a dialog box appears that says: *Transfer complete*. Select *Ok* in the dialog box and remove the floppy disk from the floppy disk drive. Send the floppy disk with the log diagnostic files to the Therma-Wave Applications Staff.

2.6.10 Read wafer imprint (WIR equipped systems only)

Wafer imprints are encoded into certain wafers. These imprints contain measurement related data. On systems with WIR's, the System Manager defines the meaning of the imprint, which can represent one or all of the following data entries: Wafer id, Run Number, Lot id, Process, or Comments. The system reads the imprint and then automatically enters the appropriate information in the Cassette Editor, Process Information and/or Process Setup data entry windows. This data and the specified windows are defined later in this section, and in Section 4, "Engineer Functions."

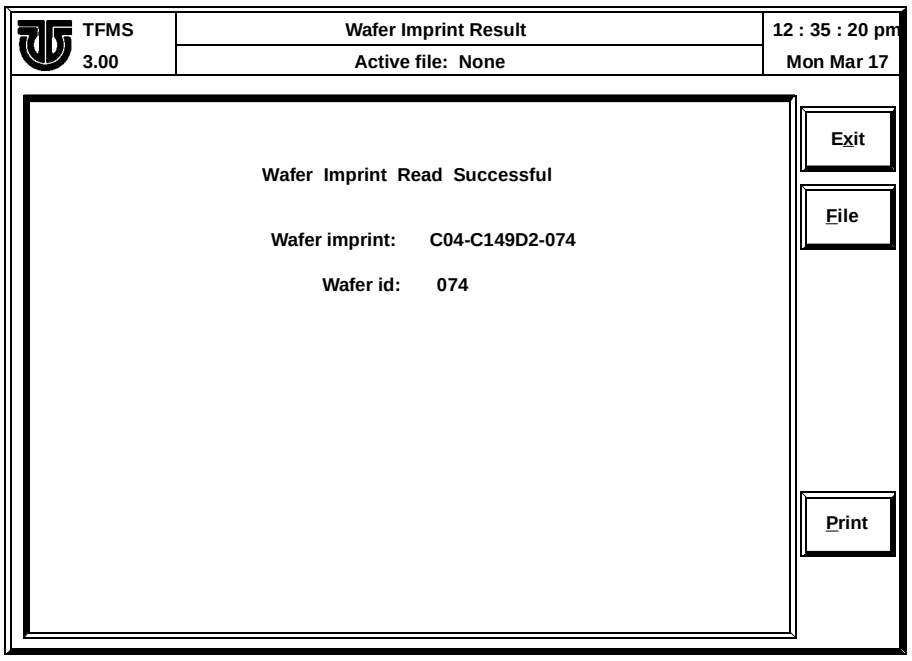
To read and display a wafer imprint, you do not have to open a job file. If the system is set up to read wafer imprints, and you select *Wafer*/*Read wafer imprint*,, the Load wafer dialog box appears, as shown in Figure 2.11. In this window, you enter the imprinted wafer's station, slot number, wafer diameter, and wafer type. If the system is not set up to read a wafer imprint and you select *Wafer*/*Read wafer imprint*, the standard Load wafer dialog box appears asking you to enter only the wafer's cassette station and slot number and then the system loads the wafer. For more information on setting up the WIR parameters, see Section 3, "Engineer Functions" and Section 7, "System Manager Functions."

Figure 2.11 WIR Load wafer dialog box



When you enter the requested information and select the *Continue* button, the system positions the wafer below the WIR and reads the wafer imprint. If the system is set up to display the wafer imprint information, it appears on the screen, as shown in the example in Figure 2.12. In this example, the system is set up to read the Wafer id (074) from the wafer imprint. The system automatically enters this Wafer id in the Cassette editor window and in the Process Information window, if it is displayed before a single wafer measurement. A *File* button appears in the window's right margin.

Figure 2.12 Wafer Imprint Result window

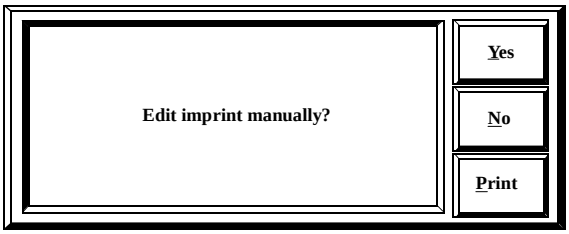


File button

This button displays the Open window (shown earlier in Figure 2.3). If you want to enter the imprinted information in a job file that is not open, you can select one in the Open window. After you open the desired job file, the system enters the imprinted information in the appropriate window(s).

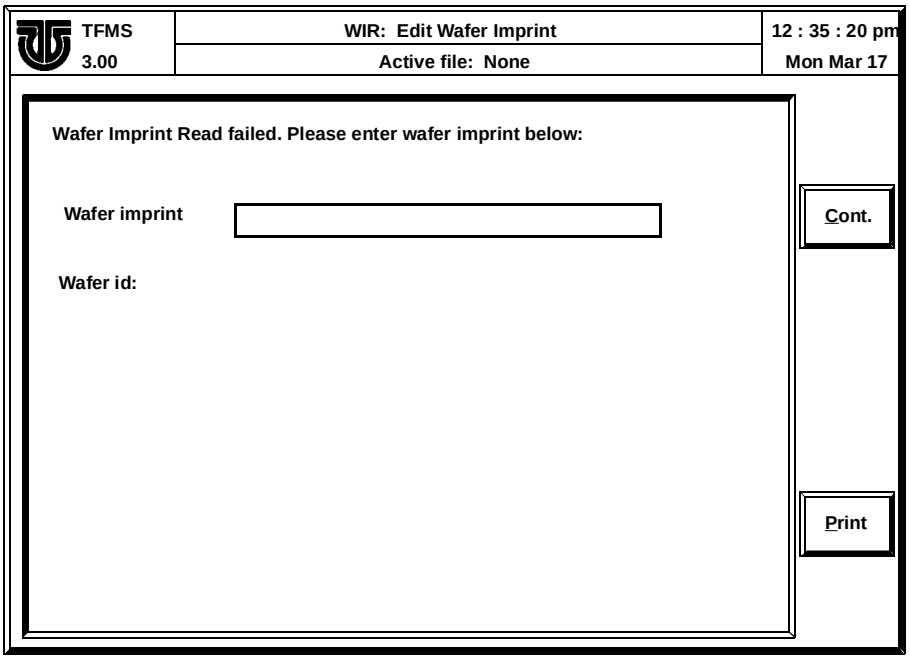
If the system cannot read the wafer imprint, a dialog box appears that asks if you want to edit the imprint manually, as shown in Figure 2.13.

Figure 2.13 Failed imprint dialog box



If you select *Yes* to edit the imprint, the WIR Edit Wafer Imprint window appears where you can manually enter the wafer imprint string, as shown in Figure 2.14.

Figure 2.14 WIR: Edit Wafer Imprint window



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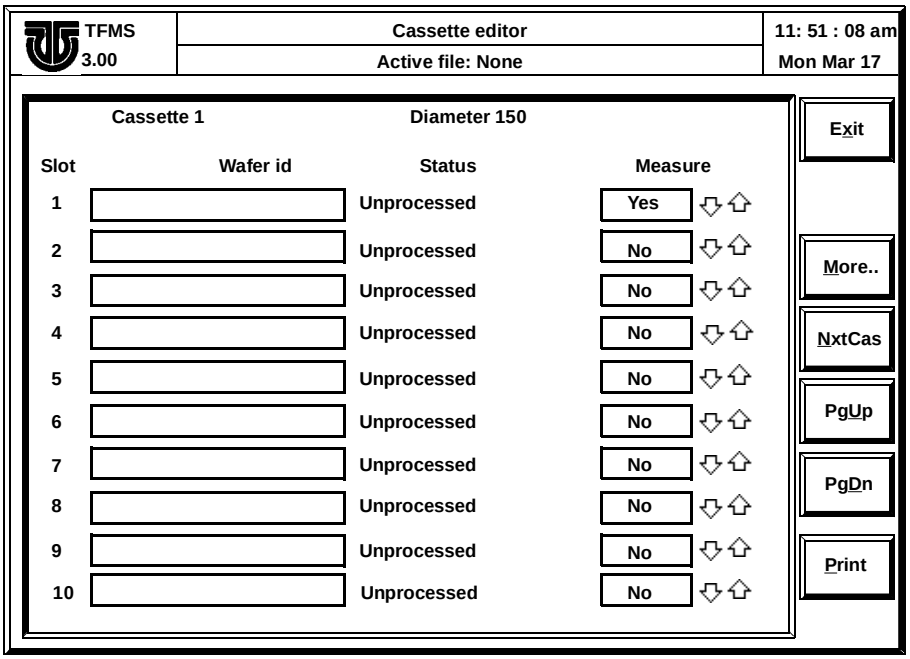
If you select the *Cont* button in this window, the system reads the new imprint entries. After a successful read, the Wafer Imprint Results window appears, as shown earlier in Figure 2.12. At this point, you can select the *Exit* button to return to the Wafer menu if the appropriate job file is already open, or select the *File* button to open the desired job file.

If you re-select *Read wafer imprint* after an initial reading and edit, and the original wafer is still loaded, a dialog box asks if you want to Re-read the imprint.

2.7 CASSETTE EDITOR

When you select *Cassette editor* in the Main menu, the Cassette editor window appears, as shown in Figure 2.15. At runtime, you can change the wafer id information and the wafers designated for measurements by selecting *Main menu*/*Cassette editor* and making entries in this window. You can also use the Cassette editor to check the wafer status information after a cassette measurement. If the active job file is set up to automatically display the Cassette editor before a measurement, it appears with some different buttons. For more information on using the Cassette editor in this mode, see *Main menu*/*Measure* later in this section, and also your "Getting Started" manual.

Figure 2.15 Cassette editor window

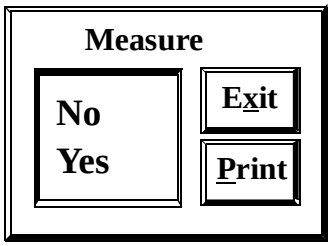


At the top of the window you see the current cassette (in this example, Cassette 1) identified along with the wafer diameter. The first ten slots in the cassette are listed by number at the left side of the window. A Wafer id field appears next to each slot number, and a Status line appears next to each Wafer id field. A Measure field appears next to each Status line. You see four new buttons in the window's right margin: *More..*, *NxtCas*, *PgUp*, and *PgDn*.

2.7.1 Measure

The first time you open the Cassette editor window, the Measure fields display information that is specified by the cassette information parameters in the active job file. You can use the Cassette editor to override these parameters. When you select any of the Measure fields, a pop-up menu appears with two options, *Yes* or *No*, as shown in Figure 2.16.

Figure 2.16 Measure pop-up menu



When you select *Yes*, the system measures the corresponding wafer during your cassette measurement. When you select *No*, the system does not measure the corresponding wafer during your cassette measurement. Instead of using the pop-up menu, you can use the toggle arrows at the right side of the field to make your selection.

2.7.2 Wafer id

When you select this Cassette editor field, a keyboard window appears where you enter a unique group of characters that identifies the corresponding wafer (See the related *Tmpl* button, later in this section).

2.7.3 Status

When you open the Cassette editor window before a measurement, the status for each wafer appears as "Unprocessed." After the system performs a successful measurement, the status information appears as "Processed." If an error causes an

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unsuccessful measurement, a brief description of the error appears in the Status line for the corresponding wafer.

2.7.4 PgUp (Page Up), PgDn (Page Down) buttons

When you select the *PgUp* or *PgDn* buttons, the previous or next page of slot numbers appears, respectively, within a cassette of wafers. There are three pages for each cassette. Page one displays slots 1-10, page two displays slots 11-20, and page three displays slots 21-25.

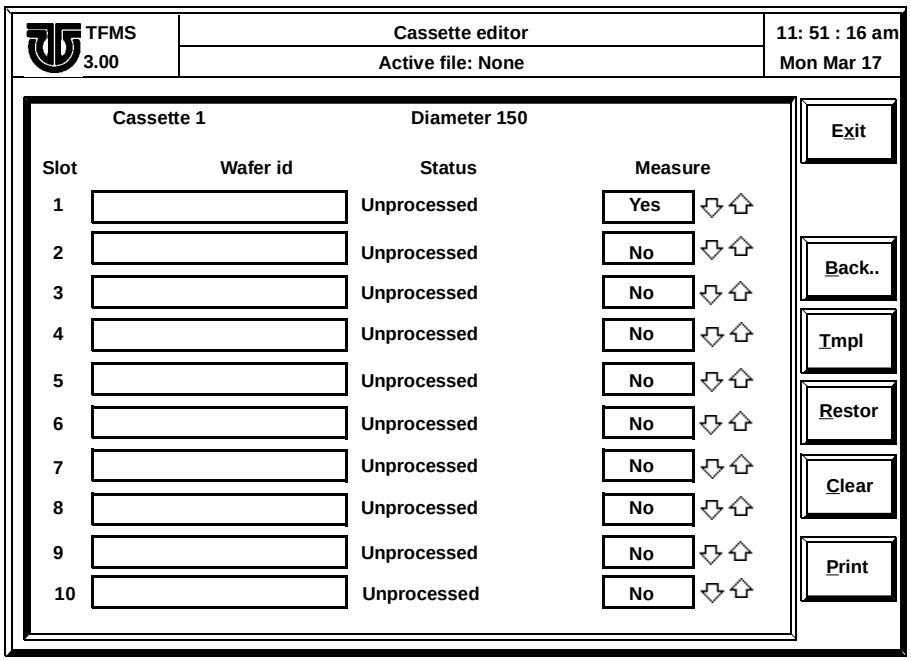
2.7.5 NxtCas (Next Cassette) button

When your job file is set up to measure two cassettes of wafers and you select the *NxtCas* button, page 1 of Cassette 2 appears. If you select *NxtCas* in the Cassette 2 window, you return to page 1 of Cassette 1. This button does not appear for one cassette measurements.

2.7.6 More.. button

When you select the *More..* button, four new buttons appear in the window's right margin, *Back..,Tmpl, Restor,* and *Clear,* as shown in Figure 2.17. You use the last three buttons to edit the Wafer id fields.

Figure 2.17 Cassette editor window (after selecting the *More..* button)



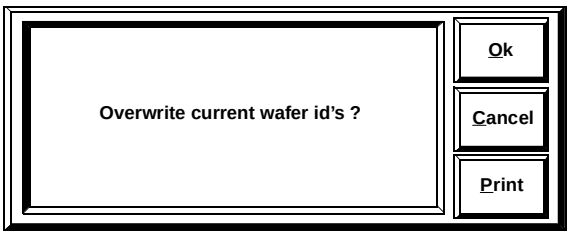
2.7.7 Back.. button

When you select the *Back.*. button, you return to the previous window (Figure 2.15).

2.7.8 Tmpl button

When you select the *Tmpl* button, a dialog box appears that says: *Overwrite current wafer id's?*, as shown in Figure 2.18. If you select the *Ok* button, the current cassette's wafer id's are replaced by the Wafer id template entry in the Cassette information window. If you select the *Cancel* button, the dialog box closes and the current wafer id's remain unchanged. For more information on the wafer id template in the Cassette information window, see Section 3, "Engineer Functions." For more information on entering wafer id's, see "Performing an automated cassette measurement" in your "Getting Started" manual.

Figure 2.18 Overwrite current wafer id's dialog box



2.7.9 Restor button

When you select the *Restor* button in the Cassette editor window, the Overwrite current wafer id's? dialog box appears, as shown in Figure 2.18. If you select the *Ok* button, the current cassette's Wafer id template entries are replaced by the previously entered wafer id's. If you select the *Cancel* button, the dialog box closes and the current wafer id's remain unchanged.

2.7.10 Clear button

When you select the *Clear* button, the Overwrite current wafer id's? dialog box appears, as shown in Figure 2.18. If you select the *Ok* button, the current cassette's wafer id's are deleted. If you select the *Cancel* button, the dialog box closes and the current wafer id's remain unchanged.

2.8 MEASURE

When you select *Measure* in the Main menu, the system runs the film measurement process as defined by the active job file. If a job file isn't open, the measurement process continues as defined by the Opti-Probe's default settings. To effectively use the Measure function, you should open a properly configured job file.

When a job file is set up for an automated cassette measurement and you select *Measure*, the robot loads a wafer and the system performs measurements on it, as defined by the active job file. When the measurements are completed, the robot unloads the wafer, returns it to its original slot (Indexer systems can return wafers to a different cassette station), and loads the next wafer for a measurement. The red indicator light on the cassette platform comes on as soon as the robot begins the load operation and stays on until the wafer is unloaded and the robot returns to the neutral position. When a job file is set up for non-automated single wafer measurements, dialog boxes appear before the load and unload operations that ask you to enter the wafer's station and slot number. For more information on the cassette/wafer setup, see Section 3, "Engineer Functions."

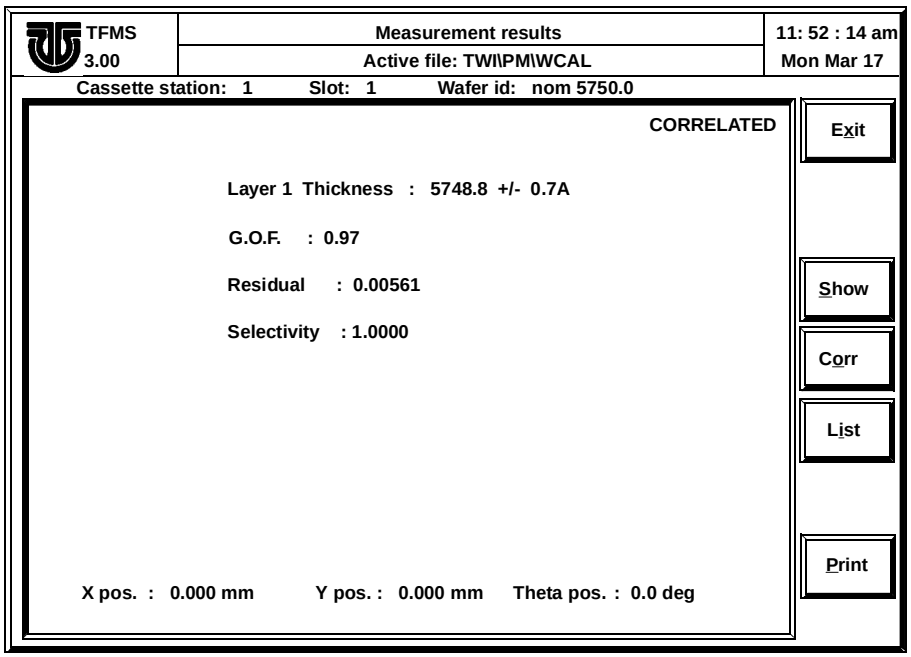
As the system measures wafers, measurement windows appear that display wafer handling information, measurement status information, and ongoing measurement data. During wafer handling, the system displays wafer loading and unloading information in the Title line and additional status information in the Status line. For step-by-step directions on performing a measurement (and examples of measurement windows), see "Performing an automated cassette measurement" and "Performing a manual single wafer measurement" in your "Getting Started" manual.

If the active job file specifies that the Process Information window should appear before a measurement, it appears after you select Measure. If the active job file is set up in Cassette mode, and it specifies that the Cassette editor (or Chain editor) window should appear at run time, the Cassette (or Chain editor) window appears. If the active job file specifies the appearance of both these windows, the Cassette (or Chain editor) window appears after you select the Go button in the Process Information window. After you select the Go button in the Process Information window or the Cassette/Chain editor window (when it appears), the system measures the specified wafer(s). The Cassette and Chain editor windows are described earlier in this section. For a description of the Process Information window and step-by-step directions on using the Cassette editor and Process Information windows at runtime, see "Performing an automated cassette measurement" in your "Getting Started" manual.

When the active job file is set up to display the measurement results, a measurement results window appears after each measurement. The example in Figure 2.19 shows a measurement results window for a single point measurement. Your "Getting Started" manual shows measurement results windows for the other measurement types. For more information on setting up the measurement results display, see "Output control" in Section 3, "Engineer Functions.

If the word CORRELATED appears near the top of a measurement results window (see Figure 2.19), the Correlation function is active, as specified by the active job file. This function correlates the measurements of the Opti-Probe with measurements from any other system, e. g., another Opti-Probe or some other thickness measurement tool, as described later in this section. Most job files are set up to save the measurement results and the correlation setup. You can recall these saved measurement records from a job file's database at any time, as described later in this section.

Figure 2.19 Measurement results window (after performing a single point measurement)



The results that appear depend on the measurement parameters specified in the active job file. For more information on setting up a job file, see Section 4, "Engineer Functions."

The Opti-Probe can report results for the following measurement parameters.

2.8.1 Film thickness

The film thickness measurement results appear at the top of the window. The value following +/- is a measurement uncertainty, which is one measure of the confidence in the accuracy of the measurement results. A smaller uncertainty generally indicates a better and more repeatable measurement. All thicknesses are expressed in Angstroms (Å) unless the System Manager reconfigures the system to display the thickness results in nanometers (nm).

2.8.2 Refractive index

The refractive index is defined by the velocity of light in a material. It is often associated with the density of the material.

2.8.3 Extinction coefficient

The extinction coefficient is defined by the amount of light absorbed by a material per unit of thickness.

2.8.4 G.O.F.

G.O.F. is a goodness of fit parameter, which is another measure of the fit quality. The value is based on the residual and can range from 0 (no fit) to 1 (perfect fit and complete confidence). The goodness of fit has less variation than the residual with thickness. However, it does not accommodate the fact that different films may typically have different residuals for the same thickness. For additional information, see Section 6, "System Expert Functions."

2.8.5 Residual

The residual is the mean-square difference (similar to the average difference) between the measured and calculated reflectivity values, so a lower residual indicates a better fit. With experience, you'll learn which residual values are good or bad for the film type and the general thickness range you're measuring.

2.8.6 Selectivity

The selectivity is a measure of the confidence the system has that the measurement did not cycle skip. The value can range from 0.5 (a competing solution was found with a residual identical to the final result) to 1.0 (there was no valid competing solution). Generally, the system only calculates this parameter for spectrometer measurements, while for non-spectrometer measurements it reports a value of 1.0.

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2.8.7 Show button

If a job file is set up to display measurement results at run time, a *Show* button appears in the measurement results window after a single point measurement. When you select the *Show* button, a sequence of Profile display windows appear that are similar to the examples in Figures 2.20 and 2.21. These profiles represent the wafer's reflectivity as a function of the angle of incidence of the light. If you perform a spectrometer measurement, a reflectivity spectrum as a function of the wavelength of light appears when you exit the profile display windows. You can only access the *Show* button and obtain the curves in these figures immediately after performing a single point measurement.

Figures 2.20 and 2.21 display both the measured and calculated profiles. Figure 2.20, the Calculated A profile window, displays s polarized light while Figure 2.21, the Calculated B profile window, displays p polarized light. Red points and a green curve appear in both figures. The red points represent the measured reflectivities at different angles of incidence. The green curve represents the calculated curve based on the film stack entered in the Film parameters window and the value(s) obtained from the best fit calculation. The residual (A or B) appears at the bottom of each window.

For single point reflectivity measurements, the reflectivity value at the selected wavelength appears in the Measurement results window. If you select the *Show* button in this window, the full reflectivity spectrum appears, as shown in the example in Figure 2.22.

You can use the *One/two* button, located in the right margin of both profile windows, to examine the curves in greater detail. For additional information on using the *One/two* button, see "Displaying a line scan measurement" in your "Getting Started" manual.

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Figure 2.20 Calculated A profile window

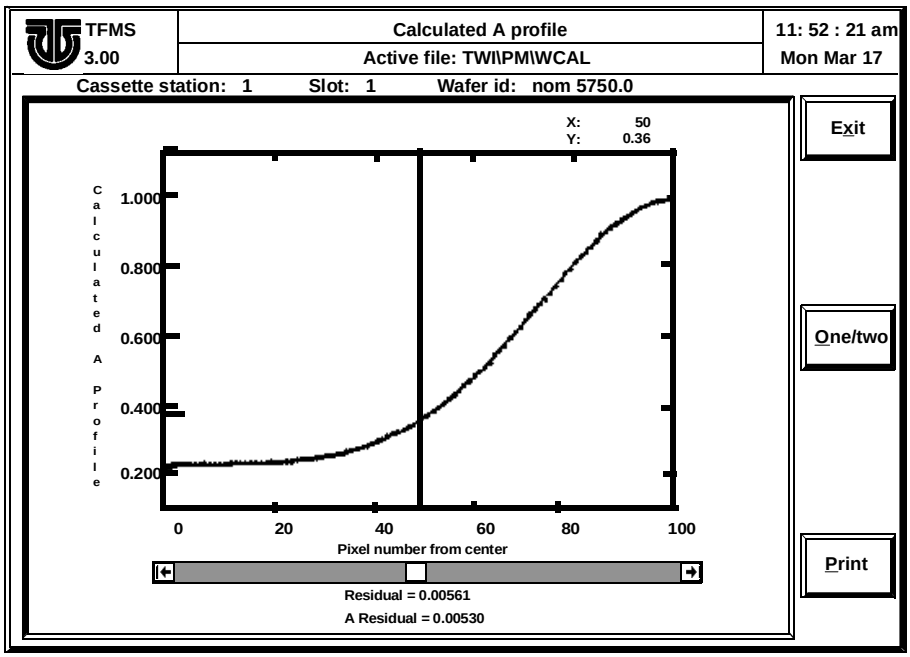
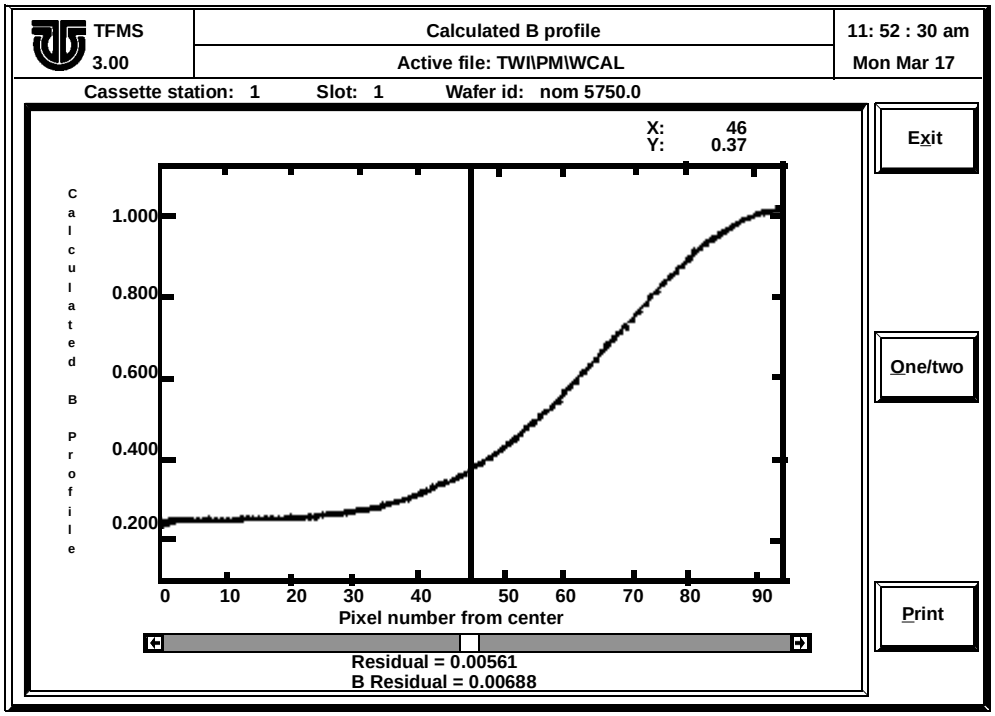


Figure 2.21 Calculated B profile window



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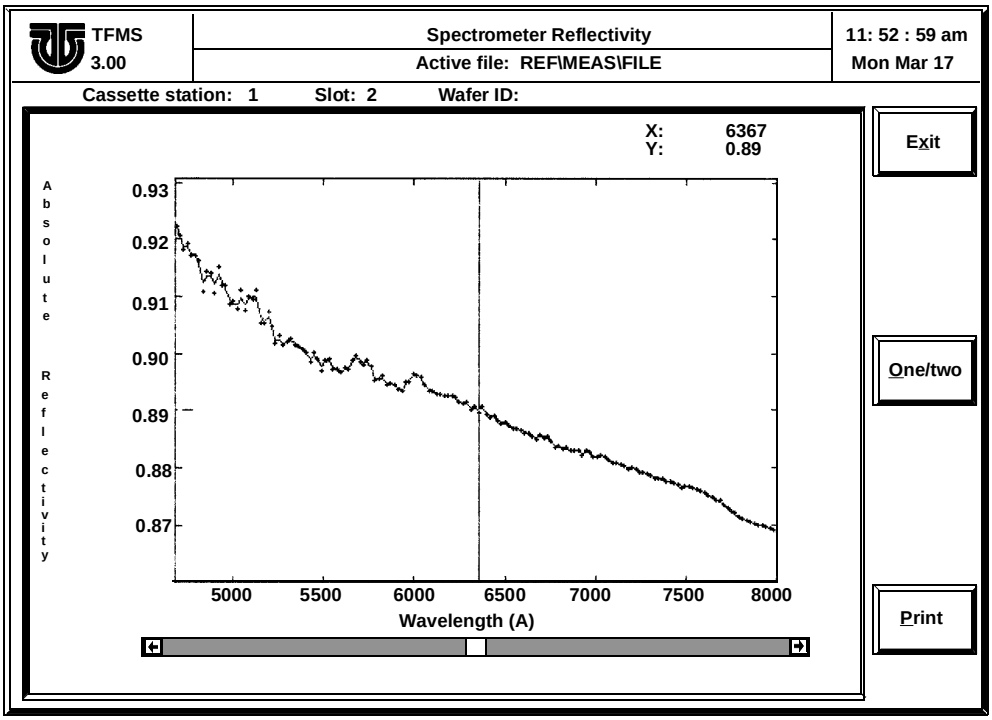
Showing the full reflectivity spectrum

When you select the *Show* button in a single point reflectivity measurement results window, the Spectrometer Reflectivity window displays the full reflectivity spectrum, as shown in the example in Figure 2.22. Therma-Wave sets the machine parameters that define the minimum and maximum wavelength values displayed in this window. For reflectivity measurements, the system obtains the reflectivity at the wavelength entered in the Measurement Setup parameters window by interpolating (cubic spline fit) points in this spectrum. For this type of measurement, the system does not use the film parameters for fitting. For more information on setting up a reflectivity measurement, see Section 3, "Engineer Functions."

Figure 2.22 Spectrometer Reflectivity window



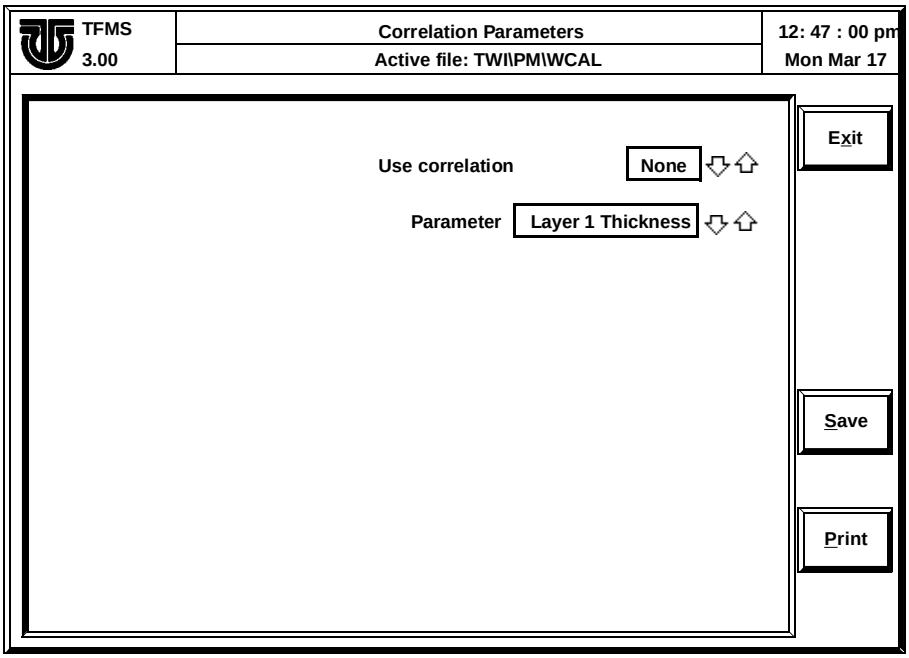
2.8.8 Corr button

When you select the *Corr* button, the Correlation Parameters window appears, as shown in Figure 2.23. In this window, you can correlate the measurements of an Opti-Probe with measurements from any other system, e. g., another Opti-Probe or some other thickness measurement tool. The Opti-Probe applies the correlation to the desired measurement parameter (e.g., film thickness). You can also apply

correlation to SPC plots, as described later in this section. The system saves correlation data with database measurement records and copies this information during Data to floppy and SECS transfers.

For the other measurement types (line scan, area scan, polar map, template), you must select the Param button in the measurement results window, and then the Corr button – to display the Correlation Parameters window.

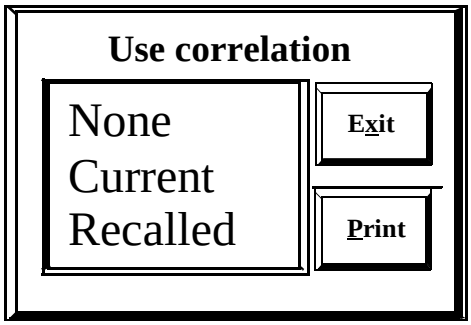
Figure 2.23 Correlation Parameters window (Correlation disabled)



Use correlation

When you select this field, three options appear, as shown in Figure 2.24.

Figure 2.24 Use correlation pop-up menu

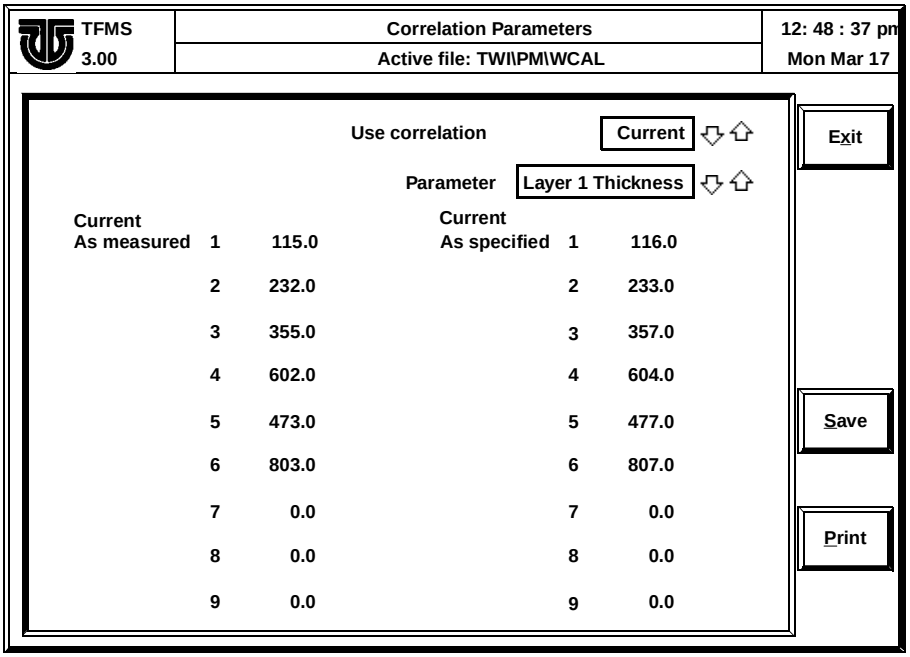


- ***None:*** This option disables the correlation function, and the Correlation Parameters window looks like Figure 2.23.

- ***Current:*** This option specifies correlated measurement results using the current correlation setup.When you select *Current* in the *Use correlation* field, a set of As measured values and a corresponding set of As specified (desired) values appears, as shown in the example in Figure 2.25. If the active job file is set up for correlation, these current values are entered in the *Setup*/*Recipe*/*Correlation* window, described in Section 4, "Engineer Functions." If the job file is not set up for correlation, these values are all 0.00. The values in the *As measured* fields represent film measurements using the same Opti-Probe.The corresponding values in the *As specified* fields represent those values you want the Opti-Probe to report.

The Correlation Parameters window's current values appear in view-only *As measured* and *As specified* fields. Although you cannot change any of these current values, you can temporarily override this setup for saved measurements. You can do this by recalling a saved measurement with different values that were current when the measurement was performed.

Figure 2.25 Correlation Parameters window (Operator level/correlation enabled)



- ***Recalled :*** This option specifies correlated measurement results using As measured values and As specified values recalled from a saved measurement (see *Display/Saved measurement*, later in this section). If the current correlation values were changed after a measurement was saved or if a measurement record was transferred from another system, the recalled correlation values can differ from the current correlation values. Measurement records that were saved using previous versions of TFMS do not contain correlation data and always use the current correlation values.

After you specify a recalled correlation, the current correlation setup is still displayed in the Correlation Parameters window. The system recalls the As measured and As specified values for the measurement results but does not display these values.

You can display correlated data in all measurement results windows. Except for single point measurement results windows, you must select the Param button, and then the Corr button to display the Correlation Parameters window where you can enable/disable correlation and/or toggle between a current and recalled correlation display. When you display a saved measurement, the measurement results window indicates that the measurement record includes correlated data, as shown in the example in Figure 2.19. In a single point display there is no Param button, and you select the Corr button in the measurement results window (see Figure 2.19) to open the Correlation Parameters window.

Parameter

In this field, you specify a measurement parameter to use for the x (e.g., film thickness). All film thicknesses are in Angstroms (Å).

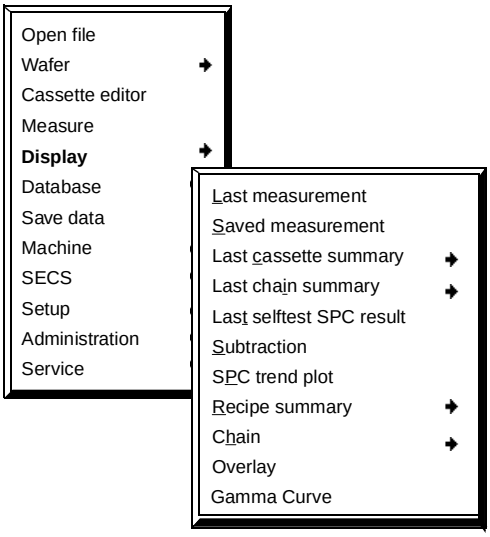
2.8.9 List button

When you select the *List* button in the Measurement results window, the system prints a Wafer Measurement Report on the printer. This report is a one-page summary of the wafer measurement, including header information from the Process Information and Measurement Setup windows, and measurement results for each point or site on the wafer. Your "Getting Started" manual includes examples of wafer measurement reports for all the measurement types.

2.9 DISPLAY

When you select *Display* in the Main menu, the Display menu appears , as shown in Figure 2.26.

Figure 2.26 Display menu



2.9.1 Last measurement

The Overlay and Gamma Curve options function on DUV systems only. For a complete description of the DUV functions, see Section 5, "DUV Functions."

When you select *Display*/*Last measurement*, a measurement results window appears displaying the results of the last measurement. For a single point measurement, this window looks similar to the example shown in Figure 2.19, excluding the *Show* button. Other examples of measurement results windows appear in Section 3, "Engineer Functions." Your "Getting Started" manual shows examples of measurement results windows for all measurement types.

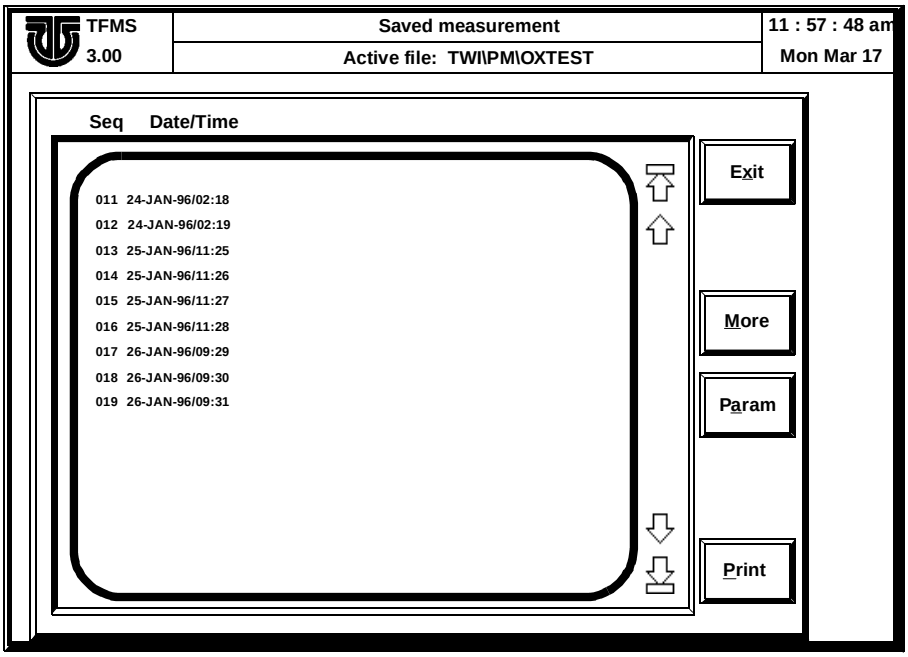
The appearance of the measurement results window is dependent upon the active job file's display parameters. You can override these parameters by selecting the *Param* button in any measurement results window (except for single point). For information on display options, see your "Getting Started" manual and also Section 3 in this manual, "Engineer Functions." If no measurement was performed after opening the active job file, a dialog box appears with a message saying: *No measurement to display.* If you see this message, select *Ok* to close the dialog box. If you select *Last measurement* after selecting *Saved measurement*, (described next), the identical dialog box appears because the system uses the same memory location for both of these options.

2.9.2 Saved measurement

When you select *Display/Saved measurement*, the Saved measurement window appears with a list of measurement records saved in the active job file's database, as shown in Figure 2.27. When you select one of these records with the light pen, a measurement results window displays the measurement. For single point measurements, this window looks similar to the example shown in Figure 2.19, excluding the *Show* button. Examples of measurement results windows for other measurement types appear in Section 3, "Engineer Functions" and your "Getting Started" manual. In addition, Section 3 explains how to configure the display parameters.

If there are no measurement records saved in the active job file's database, a dialog box appears that says: *No measurement records*. If you see this message, select *Ok* to close the dialog box.

Figure 2.27 Saved measurement window



You also see scrolling arrows at the top and bottom sides of the list. You use the scrolling arrows to move through an extended list of measurement records when the entire list cannot be displayed because it is too long. For more information on how to use the scrolling arrows, see Section 2, "Getting Started."

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The owner of the job file defines the default appearance of this window and all other database windows by selecting up to five identification fields for each record. You can temporarily override this setup using the *Param* button, as explained later. You can select from the options listed below.

Unused - No data displayed in field.

Sequence Number - Displays the sequence (record) number. Measurement records are numbered chronologically starting with 1

Date/time - The date and time the measurement was made.

Cassette/Slot - The cassette station and slot number of the wafer.

Lot ID - The lot identifier entered in the Process Information window at run time.

Wafer ID - The wafer ID entered in the Cassette editor window at run time (cassette measurement only).

Run number - The run number identifier entered in the Process Information window at run time.

Type - Measurement - Abbreviated identifiers that are defined as follows: (For a description of the measurement types, see Section 3, "Engineer Functions")

SGPT = single point

LINE = line scan

AREA = area scan

TMPL = template

POLR = polar map

Dispersion Wavelength - The wavelength at which the system reports the calculated N and K values.

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GOF - Measurement -	Displays the average goodness of fit value for a wafer measurement
Residual - Measurement -	
Layer Thickness -	Average, Sigma, Range, Min/Max, Uniform
Reflect Lmag, Reflect Hmag (wavelength)	Average, Sigma, Range, Min/Max, Uniform The low magnification and high magnification laser diode or spectrometer reflectivity measurement results at the appropriate wavelength.
Reflect Sspt, Reflect Lspt (wavelength) - DUV systems only	Average, Sigma, Range, Min/Max, Uniform The small spot and large spot UV reflectivity measurement results at the wavelength specified by the active job file.

You can temporarily override the appearance of this window by using the Param button, described below.

Param button

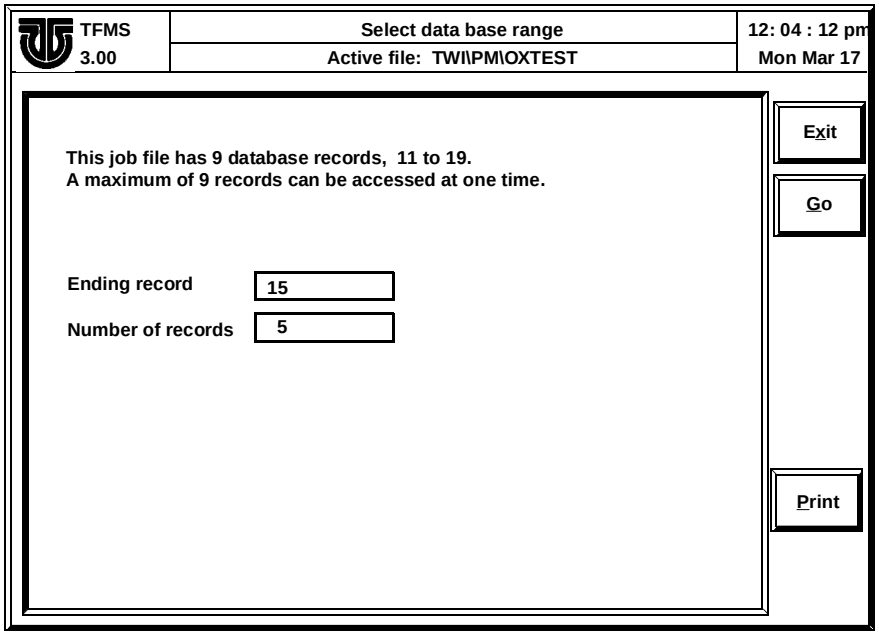
When you select the *Display*/*Saved measurement* /*Param* button, the Database index setup window appears, where you can specify which display fields appear. This feature temporarily overrides the job file's default database display setup. For complete details on configuring the Database index, see "Index" in Section 3, "Engineer Functions."

More button

When you select the *Display*/*Saved Measurement* /*More* button, the Select data base range window appears, as shown in the example in Figure 2.28 (with 9 records saved in the database). You see a *Go* button in the right margin and two fields, *Ending record* and *Number of records*. You can display a range of records in the Saved measurement window by making entries in these fields and then selecting the *Go* button. The default number of records that the system displays is the total number of records saved in the database. When the number entered by the System Manager in the System parameters window is less than the actual number of saved records, the system displays the smaller number. For a very large database, a small default entry allows faster access to the job file and its database.

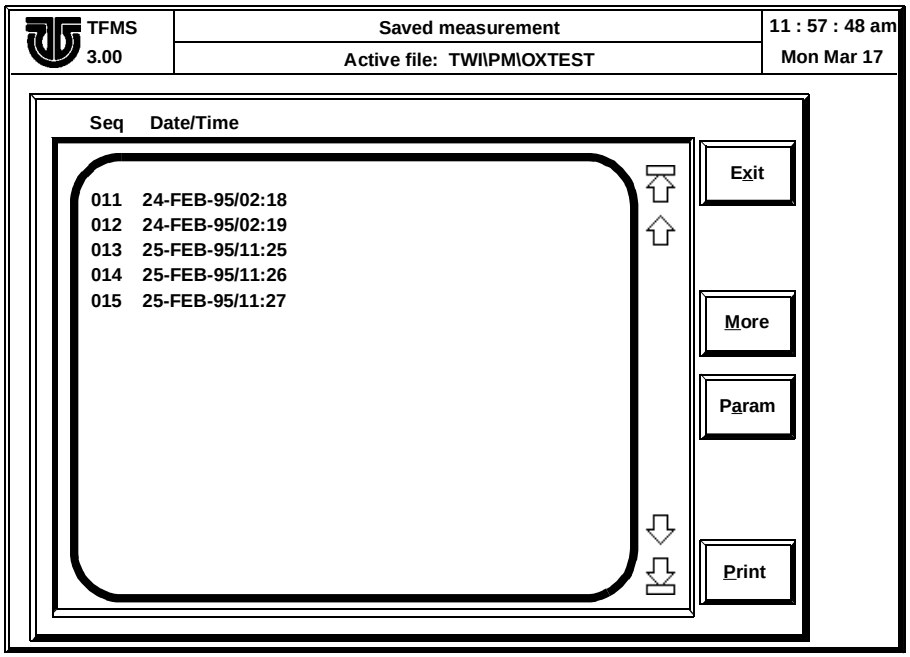
You can temporarily override this default setting by entering a larger or smaller number of records in this window.

Figure 2.28 Select data base range window



- ***Ending record:*** In this field, you can enter the last record that you'd like to display.
- ***Number of records:*** In this field, you can enter the number of records you'd like to display.
- ***Go button:*** When you select the *Display/Saved Measurement /More/Go* button, the range of records you selected appears in the Saved measurement window, as shown in Figure 2.29.

Figure 2.29 Saved measurement window (after selecting a range of records)

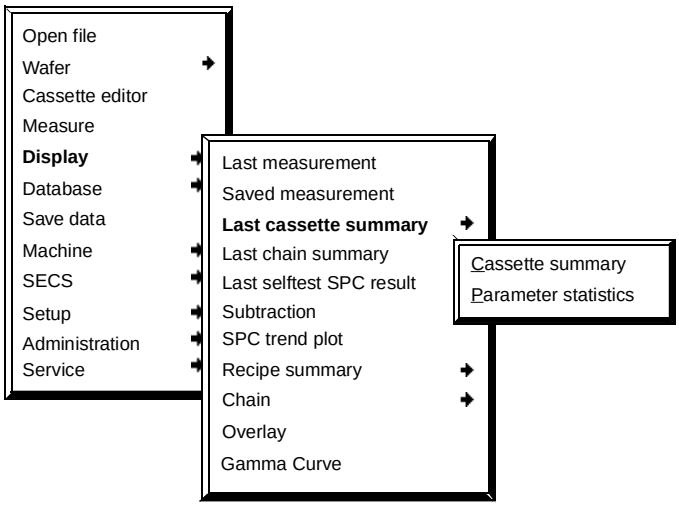


2.9.3 Last cassette summary

You can save any number of measurements in a job file until the Opti-Probe's hard disk is full. However, Therma-Wave recommends that you save no more than 3000 records in a job file. When you reach this limit, either delete some old records or save the additional records in a new job file.

When you select *Display*/*Last cassette summary*, the Last cassette summary menu appears, as shown in Figure 2.30.

Figure 2.30 Last cassette summary menu

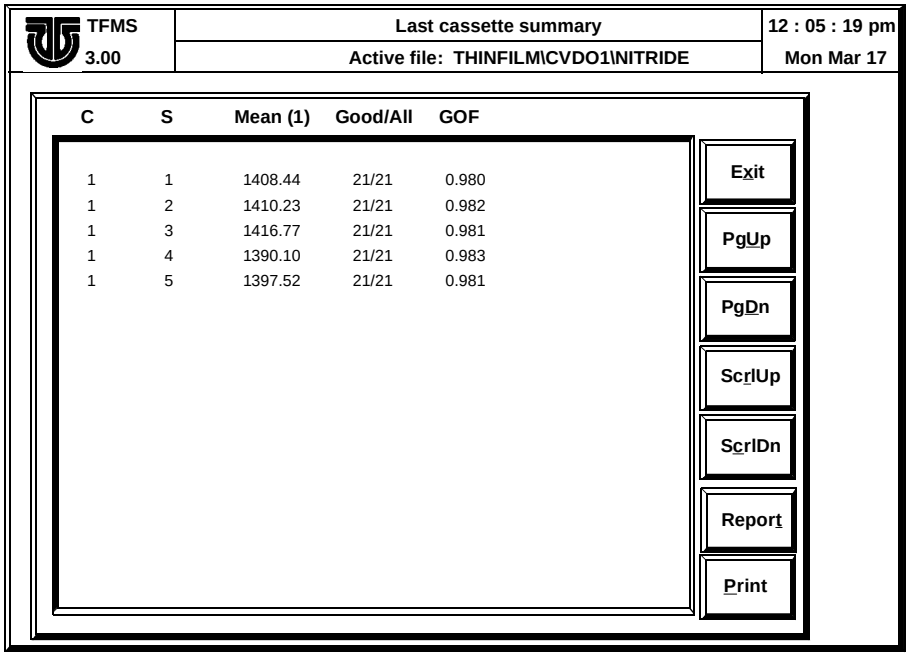


Cassette summary

When you select *Cassette summary* after performing a cassette measurement, a run summary appears in the Last cassette summary window. It displays the run summary for the last cassette measurement, as shown in the example in Figure 2.31. *PgUp*, *PgDn*, *ScrlUp*, *ScrlDn*, and *Report* buttons appear in the window's right margin. The run summary contains a one-line description of the measurement results for each wafer. This description includes the following information: cassette number, slot number, average results for all measurement parameters, GOF good points/Total points measured, and average GOF value. The last cassette summary can include either one or two cassettes.

If a cassette measurement was not performed after opening the active job file, a dialog box appears with a message that says: *No summary information to display.* If you see this message, select *Ok* to close the dialog box.

Figure 2.31 Last cassette summary window (run summary)



- ***PgUp, PgDn buttons:*** Move through each page of measured wafers. In this window, each page contains 16 lines. You use the *PgUp* button to move up one page, and the *PgDn* button to move down one page.

- ***ScrlUp, ScrlDn buttons:*** Scroll through the list of measured wafers. You use the *ScrlUp* button to scroll up one line, and the *ScrlDn* button to scroll down one line.

- ***Report button:*** Prints a copy of the Cassette summary report (shown in Section 3, "Engineer Functions"). This report is a one-page summary of the cassette measurement that includes job file related data and statistical information for each wafer designated for a measurement.

Parameter statistics

When you select *Display*/*Last cassette summary* /*Parameter statistics*, the Parameter statistics window appears, displaying the active job file's measurement parameters, as shown in the example in Figure 3-32 for a one parameter measurement.

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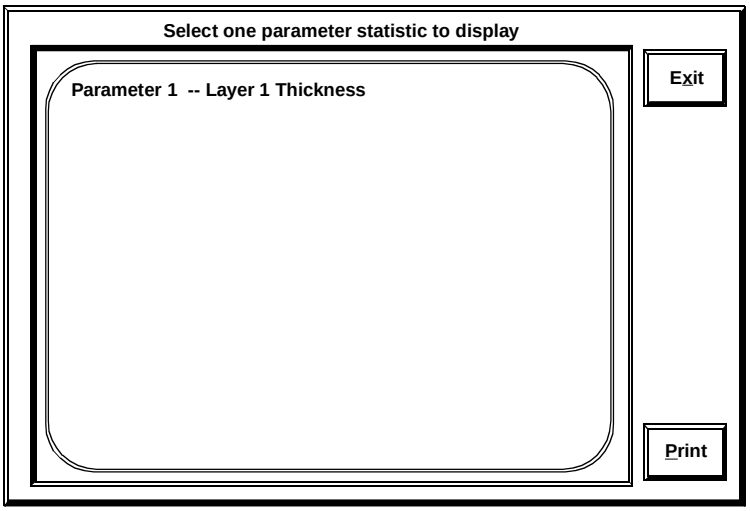
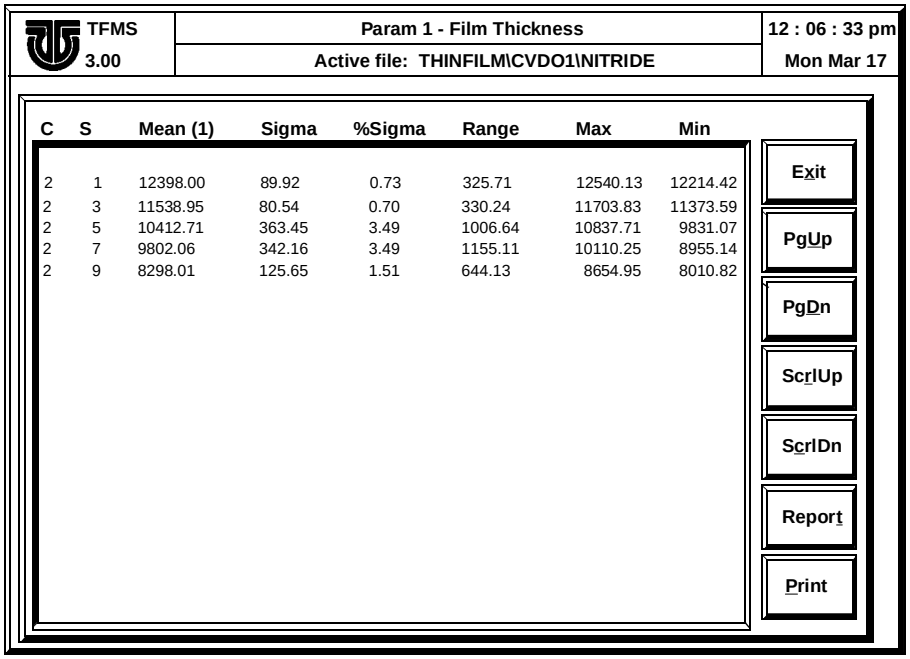
Figure 2.32 Parameter statistics window



When you select a parameter in the *Display*/*Last cassette summary* /*Parameter statistics* window, the statistics appear for the corresponding parameter, as shown in the example in Figure 2.33 for parameter 1. These statistics include the following information for each parameter: a list of means and other data that correspond 1 to 1 with each of the measurements displayed in the Last cassette summary window and the Sigma,% Sigma, Range, Max, and Min for Parameter 1 for each wafer.

- ***Report button :***Prints the selected statistics, which includes all the information displayed in the above window. In addition, this report shows the GOF good points/Total points measured, and the average GOF value.

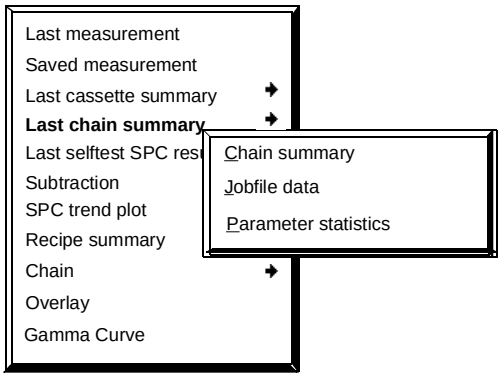
Figure 2.33 Param 1 statistics window



2.9.4 Last chain summary

When you select *Display/Last chain summary,* the Last chain summary menu appears, as shown in Figure 2.34.

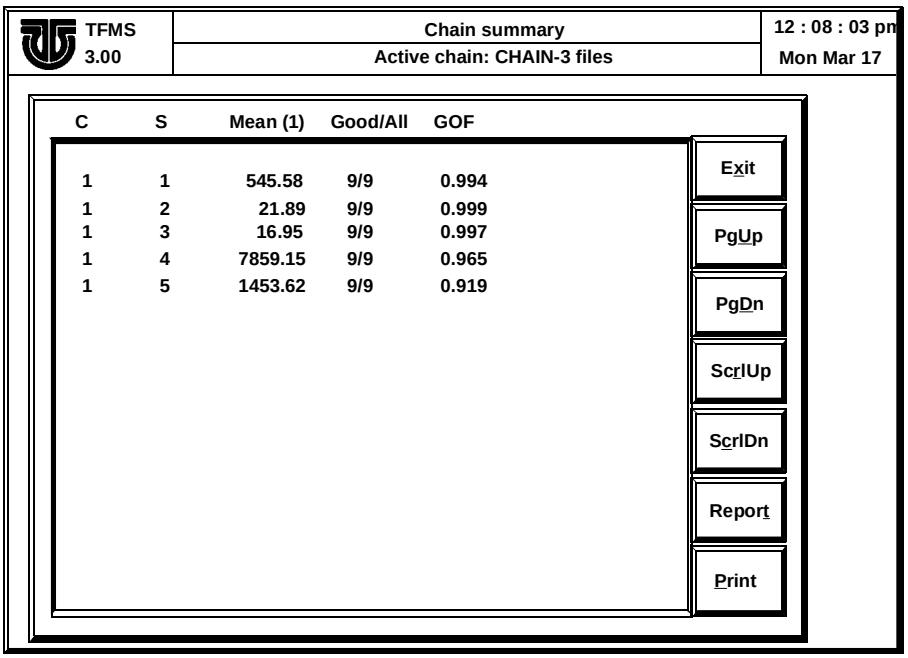
Figure 2.34 Last chain summary menu



Chain summary

When you select Chain summary in the Last chain summary window, the *Chain summary* window appears, as shown in Figure 2.35. The Chain summary window displays the run summary for the last job file chain measurement and contains a one-line description of the measurement results for each wafer.

Figure 2.35 Chain summary window



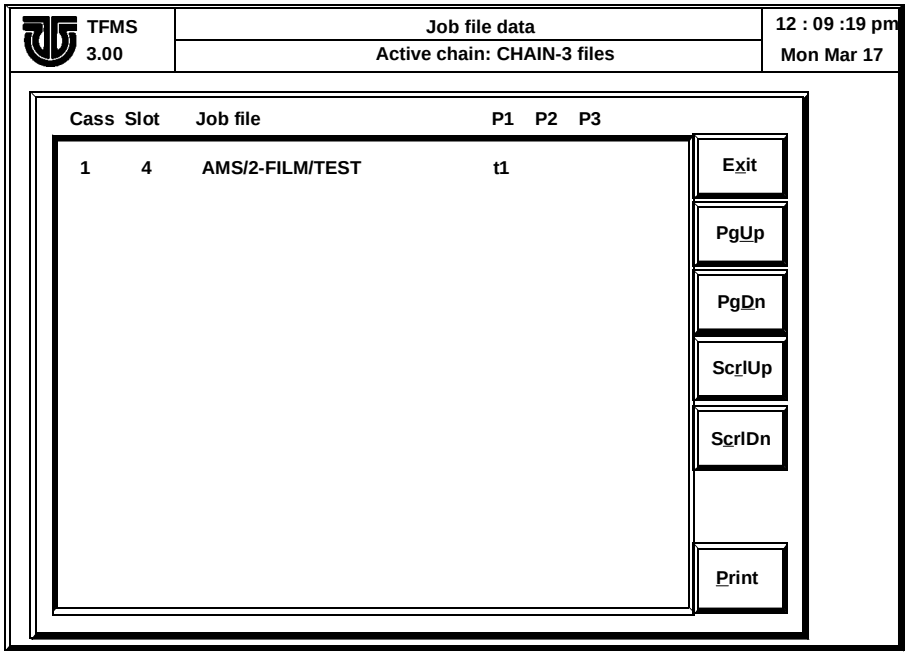
- ***Report button:*** When you select the *Report* button in the *Display*/*Last chain summary*/*Chain summary* window, the system prints a copy of the Chain summary report, which includes all the information displayed in the Chain summary window. In addition, this report names each job file used in the chain, shows the parameter(s) measured, and indicates whether each measurement was completed.

Job file data

When you select *Display*/*Last chain summary*/*Job file data*, the Job file data window appears, as shown in the example in Figure 2.36. This window displays a list of job files that correspond 1 to 1 with each of the measurements displayed in

the Chain summary report along with the measured parameters for each of those job files.

Figure 2.36 Job file data window



Parameter statistics

When you select *Display*/*Last chain summary*/*Parameter statistics*, the Parameter statistics window appears, displaying the active chain's measurement parameters. This window looks similar to the example shown earlier for the active job file parameter statistics.

When you select a parameter, the following information appears: a list of means and other data that correspond 1 to 1 with each of the measurements displayed in the Chain summary report and the Sigma,% Sigma, Range, Max, and Min for Mean (1) for each wafer.

- ***Report button:*** This button prints a copy of the selected statistics, which includes all the displayed parameter statistics and also: the parameter measured, GOF good points/total points measured, and the average GOF value.

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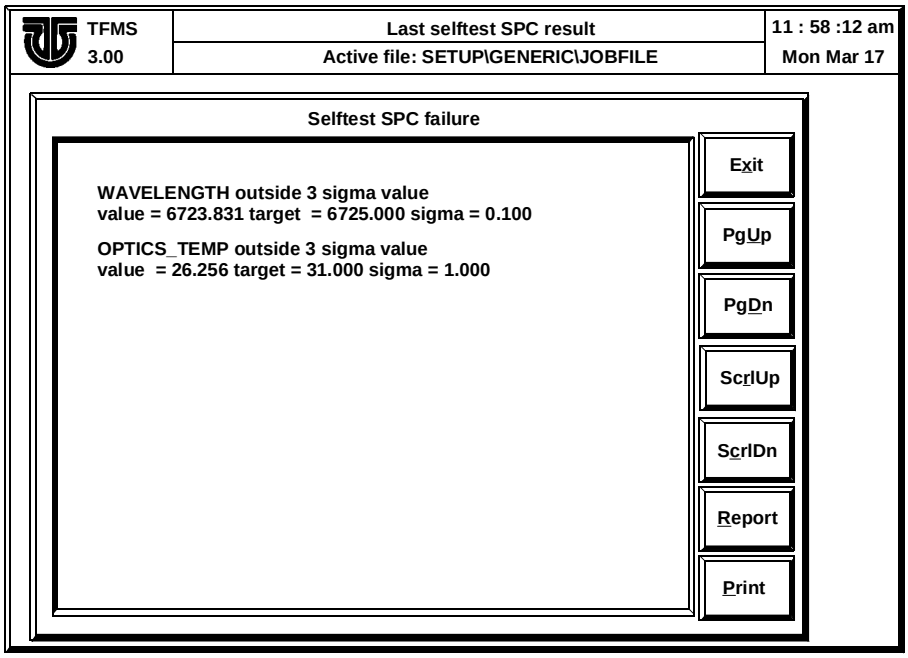
2.9.5 Last selftest SPC result

When you select *Display*/*Last selftest SPC result* and any SPC violations occurred during the last selftest, the results appear in the Last selftest SPC result window, as shown in the example in Figure 2.37. If no SPC violations occurred, a dialog box appears that says: *No selftest database failures to report*.

This window displays the SPC violation(s) and related data that caused the selftest to fail. The *Report* button prints all the SPC violation statistics.

Figure 2.37 Last selftest SPC result window

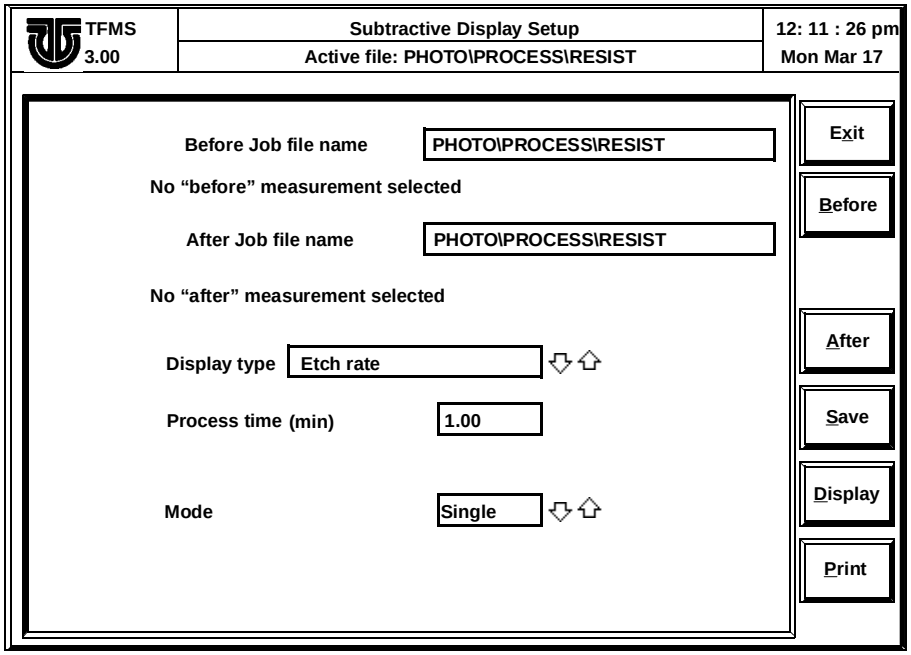


2.9.6 Subtraction

When you open a job file and select *Display*/*Subtraction*, the Subtractive display setup window appears, as shown in Figure 2.38. If you select *Subtraction* and a job file is not open, a dialog box appears with a message saying: *Please select a job file before proceeding.* If you see this message, select *Ok* to close the dialog box and open the desired job file.

In this window, you can calculate the difference between two film thickness measurements on the same film type. You can obtain the two sets of measurement data from one or two job files.

Figure 2.38 Subtractive Display Setup window



Before Job file name, After job file name

These fields specify the "before" and "after" job files used to obtain the two film thickness measurements for the subtraction calculation. The default window displays the active job file name in each field, indicating that the same job file is used for both sets of data, as shown in Figure 2.38. When you select these fields, the *Select* window appears, which looks like the Open window (excluding the *Chain* button). In this window, you can select the same or different before and after job files. After you make your selection, the job file names appear in their respective fields.

Before line and button

When you activate a job file and open the Subtractive display setup window, you see a line saying: *No "before" measurement selected.* You also see a *Before* button in the window's right margin. After you enter a before job file name and select the *Before* button, the Select "before" measurement window appears showing a list of measurements saved in the before job file's database, and you can select the

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desired measurement. The Select "before" measurement window functions like the Saved measurement window, described earlier in this section. After you select a measurement, the Subtractive display setup window reappears, and the *before* line displays the name of the selected measurement record.

After line and button

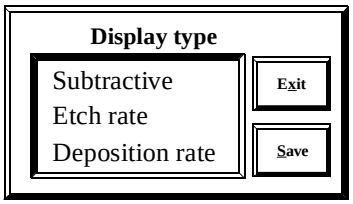
Works the same way as the *before* line and button.

Display type

This field specifies the type of subtractive display. It provides you with three options, as shown in Figure 2.39. These options are defined as follows:

- ***Subtractive:*** equals the "before" measurement minus the "after" measurement.
- ***Etch rate:***equals the "before" measurement minus the "after" measurement, divided by the process time.
- ***Deposition rate :***equals the "after" measurement minus the "before" measurement, divided by the process time.

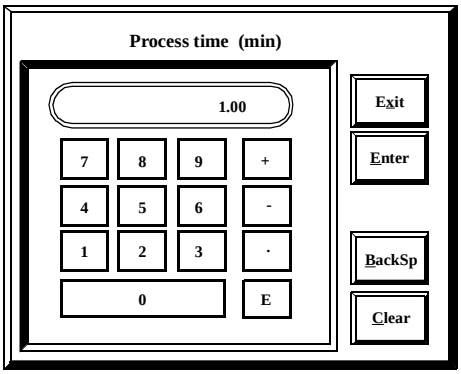
Figure 2.39 Display type pop-up menu



Process time (min)

When you select *Process time (min)* in the Subtractive Display Setup window, a calculator window appears where you can specify the process time (in minutes) for the Etch rate and Deposition rate displays.

Figure 2.40 Process time calculator window



Mode

This parameter specifies either *Single* (standard) or *Lot* mode. When you select *Lot*, the system searches the before and after job files for sequence numbers with the same Lot ID, then sequentially calculates the differences for each before and after measurement that have matching wafer ID's.

Display button

The *Display* button appears in the Subtractive Display Setup window's right margin, as shown in Figure 2.38. When you select this button, the subtracted data for the (top) film thickness appears in a measurement results window, as shown in the example in Figure 2.41. This window looks similar to the one that appears when you select *Last Measurement*, with the addition of the "before" and "after" record information.

When your job file is set up for an area scan or polar map, this window looks similar to the example in Figure 2.41 for an area scan. In addition, if you selected Etch rate or Deposition rate, the units of the subtracted data are Angstroms/minute.

To be subtracted, the "before" and "after" measurement types must generally be the same. This is automatic for measurement setups that are unchanged between the "before" and "after" measurements. Specifically, the following setup parameters must be the same:

- Number of films, choice of films and substrate.
- Number and choice of measurement parameters.
- Wafer diameter.

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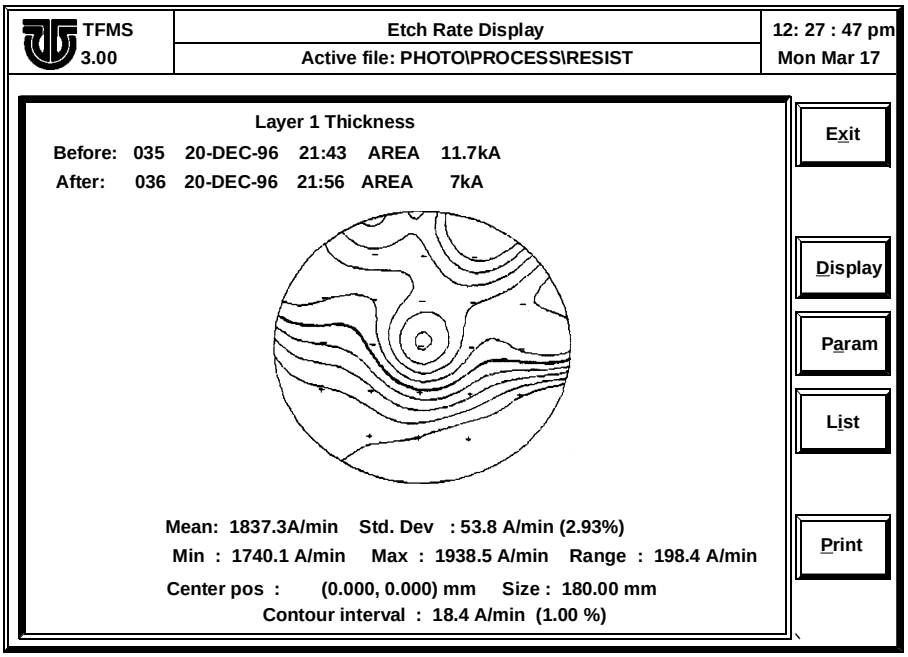
- Measurement type: single pt., line scan, area scan, template, or polar map.
- Measurement site coordinates on both wafers.

When you select *Display* and the "before" and "after" measurements cannot be subtracted, a dialog box appears that explains why. If you see this dialog box, select *Ok* to close it.

Figure 2.41 Subtracted data/measurement results window (etch rate display for an area scan)


TFMS
3.00
Etch Rate Display
Active file: PHOTO\PROCESS\RESIST
12: 27 : 47 pm
Mon Mar 17
Layer 1 Thickness
Before: 035 20-DEC-96 21:43 AREA 11.7kA
After: 036 20-DEC-96 21:56 AREA 7kA
Exit
Display
Param
List
Print
Mean: 1837.3A/min Std. Dev : 53.8 A/min (2.93%)
Min : 1740.1 A/min Max : 1938.5 A/min Range : 198.4 A/min
Center pos : (0.000, 0.000) mm Size : 180.00 mm
Contour interval : 18.4 A/min (1.00 %)

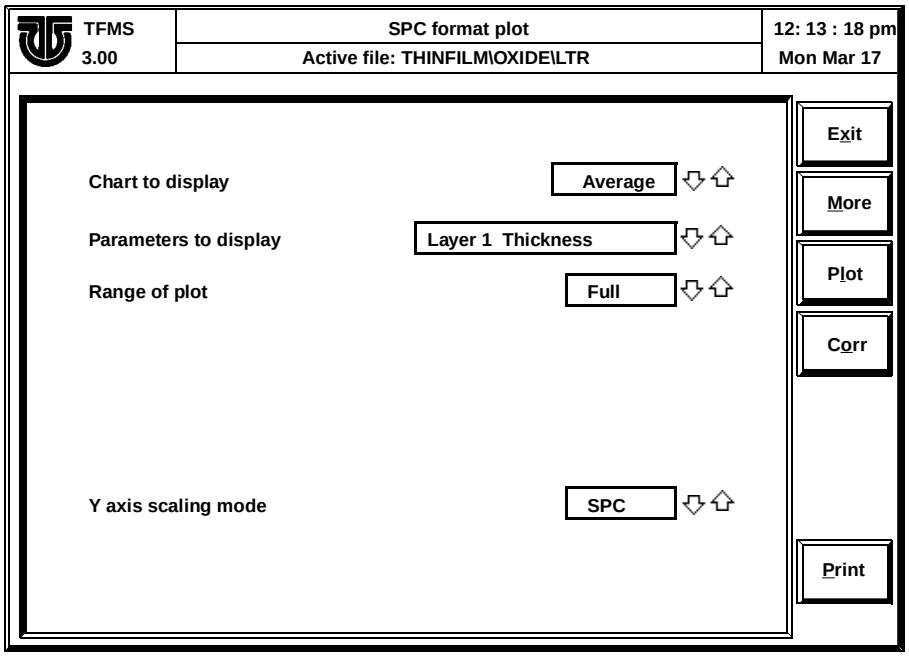
Following is a description of the additional buttons in the Subtractive data measurement results window.

- ***Display button:*** If you select the *Display* button in a Subtracted data measurement results window (refer to the example on the previous page), the results toggle between a map and a tabular display. For examples of these two displays, see Section 3, "Engineer Functions."
- ***Param button:*** If you select the Param button, a display parameters window appears where you can modify the subtracted data display. For instructions on configuring the display parameters, see your "Getting Started" manual, and also Section 3 in this manual, "Engineer Functions."
- ***List button:*** Prints a list of results of the subtraction calculation.

2.9.7 SPC trend plot

When you select *Display*/*SPC trend* plot, the SPC format plot window appears, as shown in Figure 2.42.

Figure 2.42 SPC format plot window



In this window, you can set up the format of your SPC plot by making entries in the following fields:

Chart to display

Specifies the type of SPC plot you want to display. When you select this field with the light pen, a pop-up menu appears with five options, as shown in Figure 2.43. These options refer to the statistics for each measurement record saved in the active job file's database. When you select one of these options with the light pen, you'll see it appear in this field.

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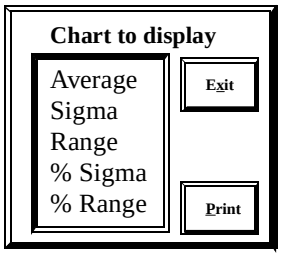
Figure 2.43 Chart to display pop-up menu



Instead of using the pop-up menu, you can select an option with the toggle arrows located at the right side of the field.

Parameters to display

When you select *Parameters to display* in the SPC format plot window, you can specify which measurement parameter statistics are displayed in the SPC plot. The options are the film parameters measured by the active job file (e.g., *Film Thickness, GOF, Residual, Film index*). For engineer level setup information on these parameters, see the Film parameters window in Section 3, "Engineer Functions."

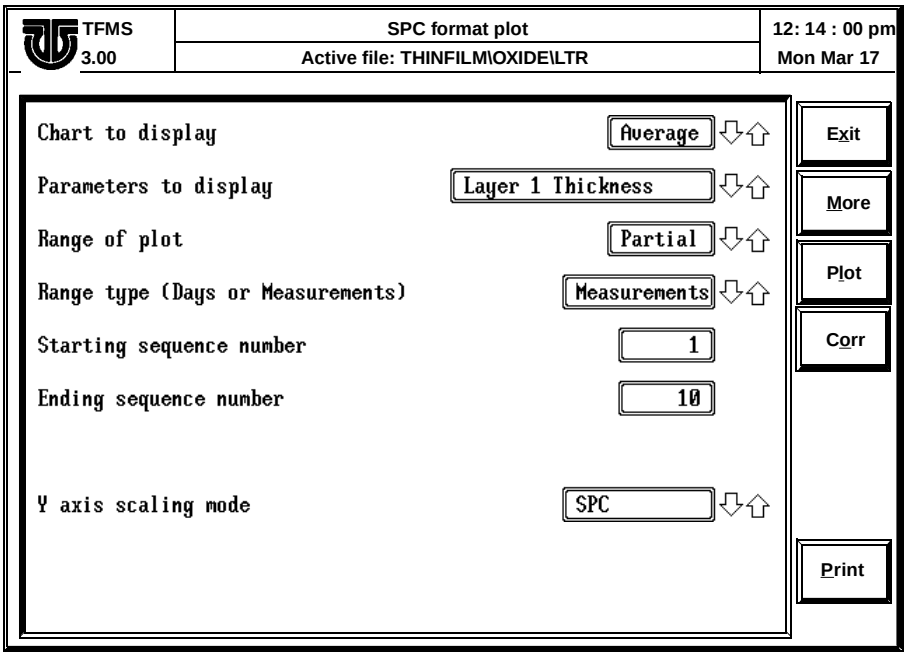
Range of plot

This parameter specifies whether the SPC plot includes all or only some of the measurements. The options are *Full* and *Partial*. When you select *Partial*, new fields appear in the window. You'll use these fields to specify the range of measurements. Two examples are shown in Figures 2.44 and 2.46.

Range type (Days or Measurements)

Specifies the range type used when the SPC plot only includes partial data. When you select this field, two options appear: *Days* or *Measurements*. The remaining fields in this window specify the beginning and end of the range, and depend on which of the two range types you select.

Figure 2.44 SPC format plot window (partial range based on measurements)



Starting sequence number, Ending sequence number

Specifies the first and last sequence (record) number in the range, as shown in Figure 2.44 for a partial range based on measurements. When you open the SPC format window, the default entries are the job file's first and last measurement records. You can change the starting and ending sequence numbers by selecting each field with the light pen. When you select one of these fields, a calculator window appears, as shown in Figure 2.45.

You type the desired sequence number with the light pen, and then select the *Enter* button in the calculator window's right margin.

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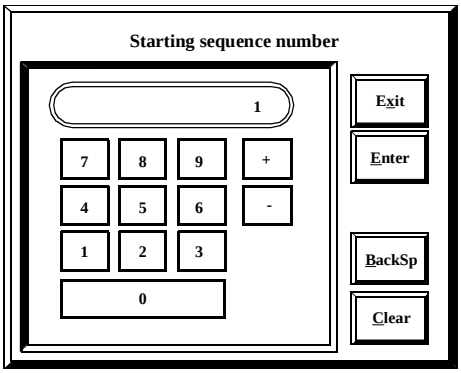
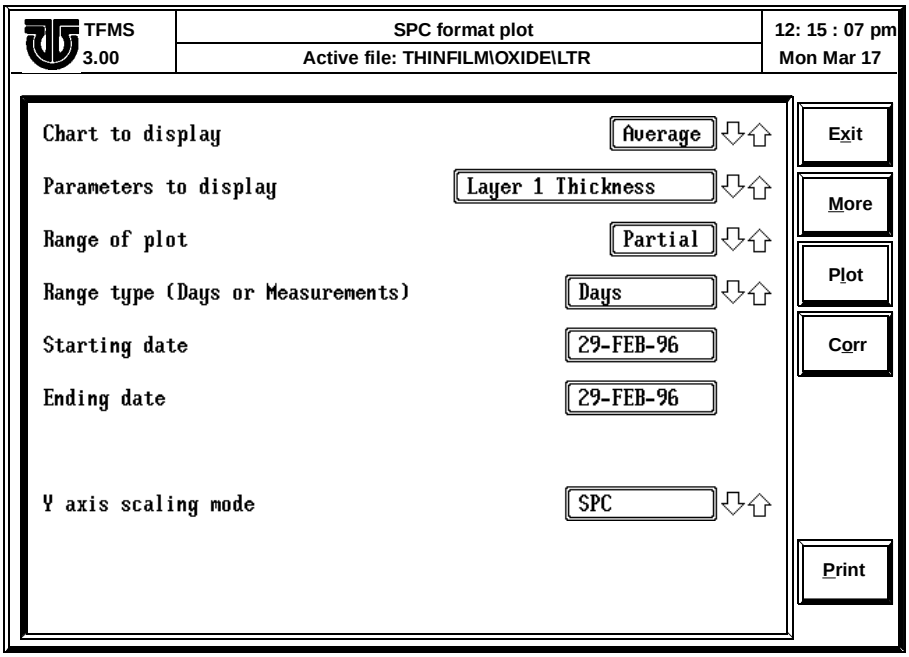
Figure 2.45 Sequence number calculator window



Starting date, Ending date

Specifies the first and last date in the range, as shown in Figure 2.46, for a partial range based on days.

Figure 2.46 SPC format plot window (Partial range based on days)



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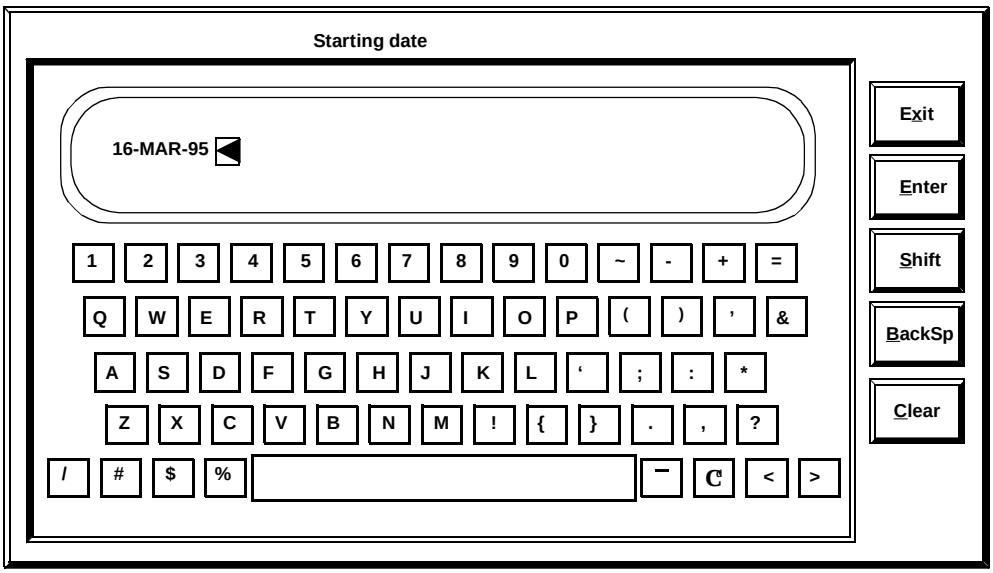
Starting date, Ending date

When you open the SPC format window and select the *Partial* and *Days* options, the default values displayed are the first and last dates that have associated saved data.

You can edit the starting and ending dates by selecting each field with the light pen. When you select one of these fields, a keyboard window appears, as shown in Figure 2.47.

Figure 2.47 Starting date keyboard window



You type the desired date with the light pen, and then select the *Enter* button in the keyboard window's right margin.

The keyboard window contains some characters that are invalid for entering dates. If you type any of these characters or a date that is inconsistent with the data in the database (e.g., an ending date which is earlier than the starting date), a dialog box appears with a reminder message. If this happens, select Ok to close the dialog box, select the date field again, and re-type the desired date.

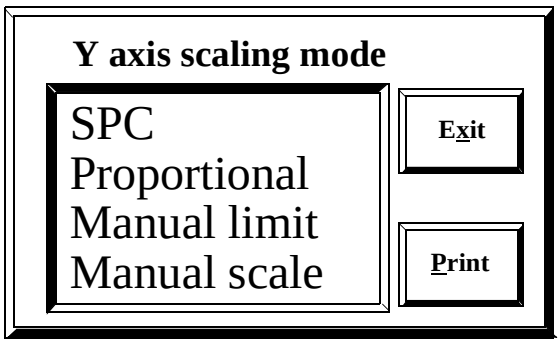
Y axis scaling mode

Specifies the mode used to display the Y or vertical axis of the SPC plot. Four options appear in a pop-up menu, *SPC*, *Proportional*, *Manual limits*, and *Manual*

scale., as shown in Figure 2.48. If you select the default, *SPC*, the system scales the plot using the SPC specification setup, as in previous TFMS releases. The other options specify the same parameters used by Engineer level users to set up a line scan display. For complete details on each of these options, see the Display control description for line scans (*Setup*/*Recipe*/*Data output*/*Display control)* in Section 3"Engineer Functions."

If you change the manual limit parameters, you may also have to change the other measurement parameters (e.g., film thickness, GOF, residual), to make sure they fall within your new range.

Figure 2.48 Y axis scaling mode pop-up menu



More button

When you select the *More* button, the Select database range window appears, as shown in the example in Figure 2.28. In this window, you can configure the SPC database display.

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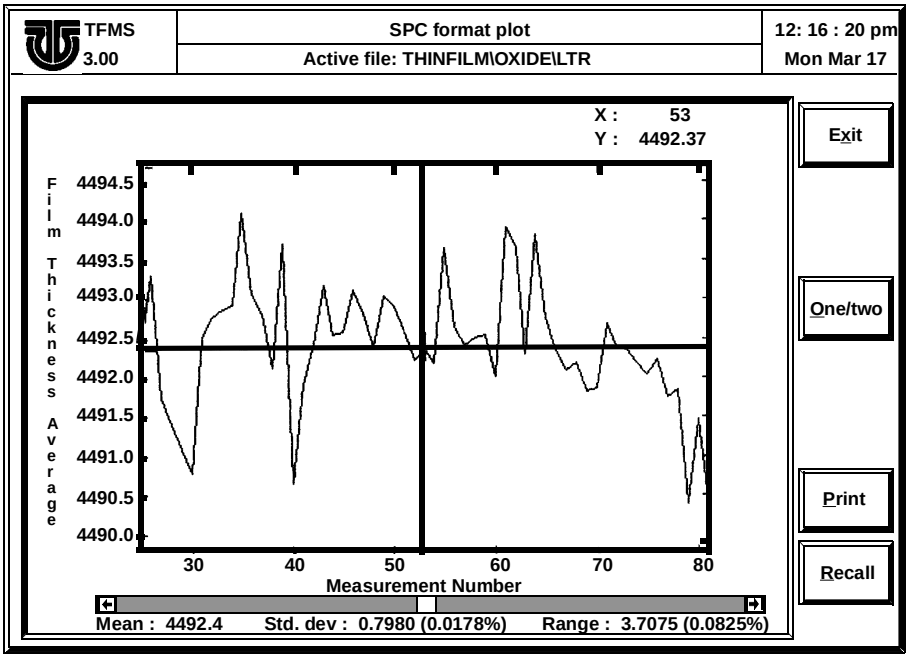
Plot button

The *Plot* button appears in the SPC format window's right margin. When you select this button, an SPC plot appears in the format you specified, as shown in Figure 2.49.

Figure 2.49 SPC format plot window



The average film thickness shown in this example is for all measurements obtained during a one-month period of a long-term repeatability experiment. Sequence numbers appear at the bottom of the graph. The mean, standard deviation, and peak-to-peak statistics for the SPC plot appear at the bottom of the window below the scroll bar. When a target value is not specified, the mean (average) is identified by a red line. For additional SPC format display options, see Section 3, "Engineer Functions." You can identify a specific measurement record by a vertical line (cursor) and the button in the scroll bar. For more information on how to use the scroll bar and the *One/two* button, see "Displaying a line scan measurement" in your "Getting Started" manual.

Recall button

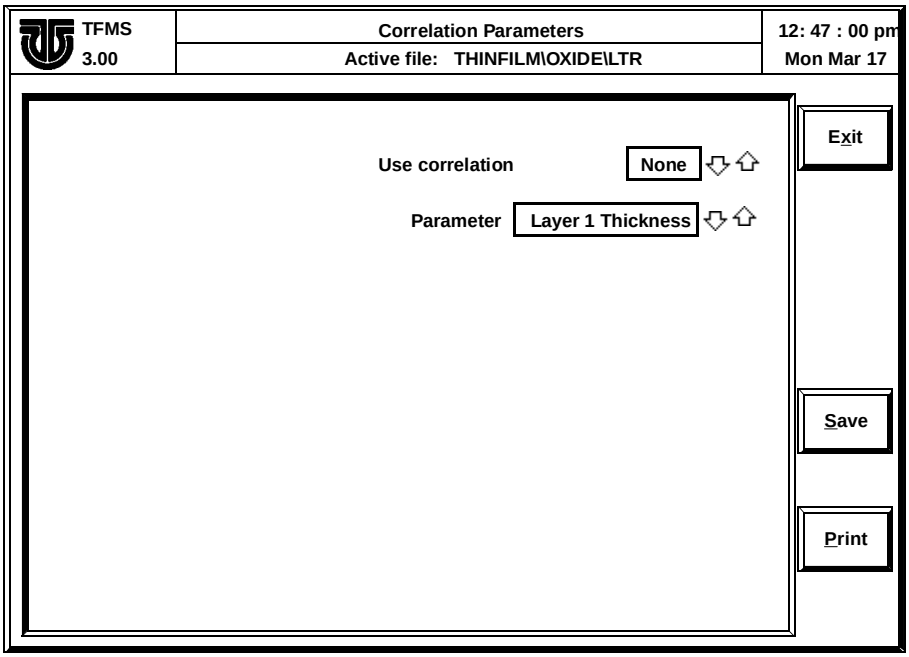
The *Recall* button appears in the SPC plot window's right margin. When you select this button, the measurement record represented by the cursor appears in a Measurement results window. This window is identical to the one you see when

you perform a Display saved measurement operation, described earlier in this section.

Corr button

When you select this button, the Correlation parameters window appears, as shown in Figure 2.50. In this window, you can correlate the measurements of an Opti-Probe with measurements from any other system, e. g., another Opti-Probe or some other thickness measurement tool. The Opti-Probe applies the correlation to the desired measurement parameter (e.g., film thickness). You can apply correlation to SPC plots and measurement results. The system saves correlation data with database measurement records and copies this information during Data to floppy and SECS transfers.

Figure 2.50 Correlation Parameters window (Correlation disabled)



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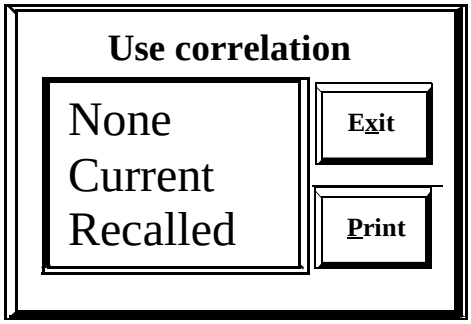
- ***Use correlation:*** When you select this field, three options appear, as shown in Figure 2.51.

Figure 2.51 Use correlation pop-up menu

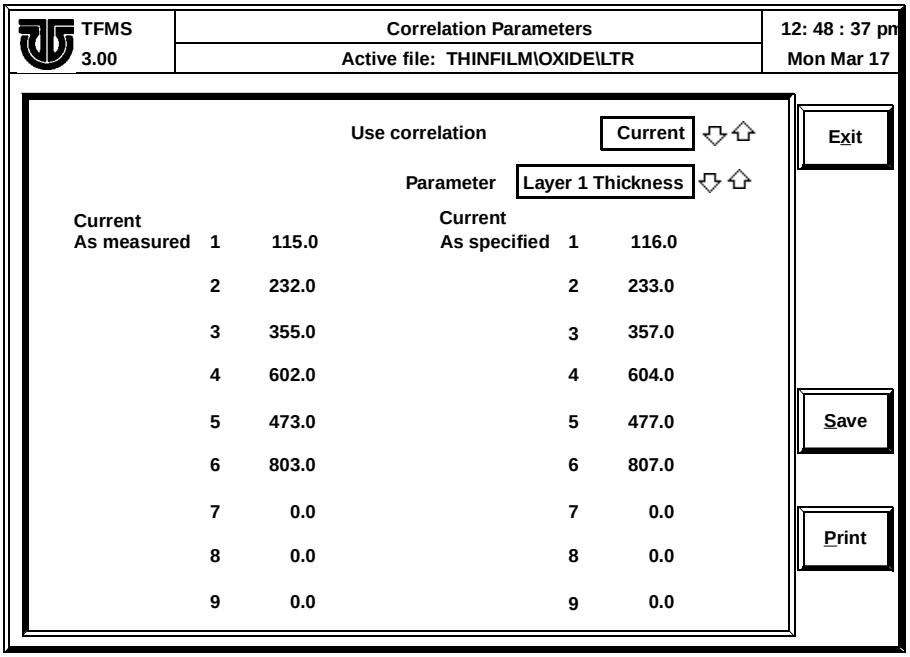


- ***None:*** When you select *None* in the *Use Correlation* field, correlation is disabled, and the Correlation Parameters window looks like Figure 2.50.

- ***Current:*** This option specifies a correlated SPC plot using the current correlation setup.When you select *Current* in the *Use correlation* field, a set of As measured values and a corresponding set of As specified (desired) values appears, as shown in the example in Figure 2.52. If the active job file is set up for correlation, these current values are entered in the *Setup*/*Recipe*/*Correlation* window, described in Section 4, "Engineer Functions." If the job file does specify correlation, these values are all 0.00. The values in the *As measured* fields represent film measurements using the same Opti-Probe.The corresponding values in the *As specified* fields represent those values you want the Opti-Probe to report.

- ***Current:*** The Correlation Parameters window's current values appear in view-only *As measured* and *As specified* fields. You cannot change any of the current values, but you can temporarily override this setup and recall different values from the database, as described on the next page. For a complete description of the Engineer level Correlation setup, which includes some additional functions, see Section 4.

Figure 2.52 Correlation Parameters window (Operator level/correlation enabled)



- ***Recalled :*** Specifies a correlated SPC plot using As measured values and As specified values recalled from the job file's database. If the current correlation values were changed after the database records were saved or if the records were transferred from another system, the recalled correlation values can differ from the current correlation values. Database records that were saved using previous versions of TFMS do not contain correlation data and always use the current correlation values.

After you specify a recalled correlation, the current correlation setup is still displayed in the Correlation Parameters window. The system recalls the As measured and As specified values to display the correlated SPC plot but does not display these values.

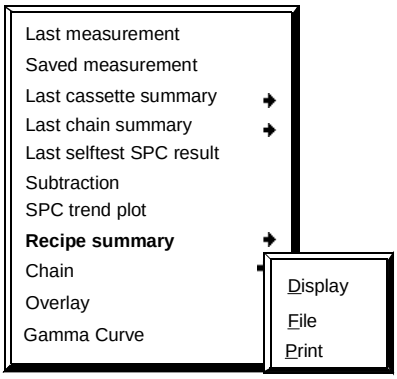
You can also display correlated data in all measurement results windows. In these windows, you select the Param and Corr buttons to display the Correlation Parameters window where you can enable/disable correlation and/or toggle between a current and recalled correlation display. When you display a saved correlated measurement, the measurement results window indicates that the measurement record includes correlated data. For single point measurements there is no Param button, and the Corr button is displayed in the measurement results window, as shown earlier in this section.

- ***Parameter:*** In this field, you specify a measurement parameter to use for the correlation (e.g., film thickness). All film thicknesses are in Angstroms (Å).

2.9.8 Recipe summary

When you select *Display*/*Recipe summary* , the Recipe summary menu appears, as shown in Figure 2.53. The job file recipe specifies film, measurement, cassette and wafer handling, and other parameters. These parameters are customized by Engineer or higher level users who enter the necessary information in various recipe setup windows. The parameters can vary, depending on a job file's configuration. For a detailed description of all the recipe parameters and possible configurations, see Section 3, "Engineer Functions."

Figure 2.53 Recipe summary menu

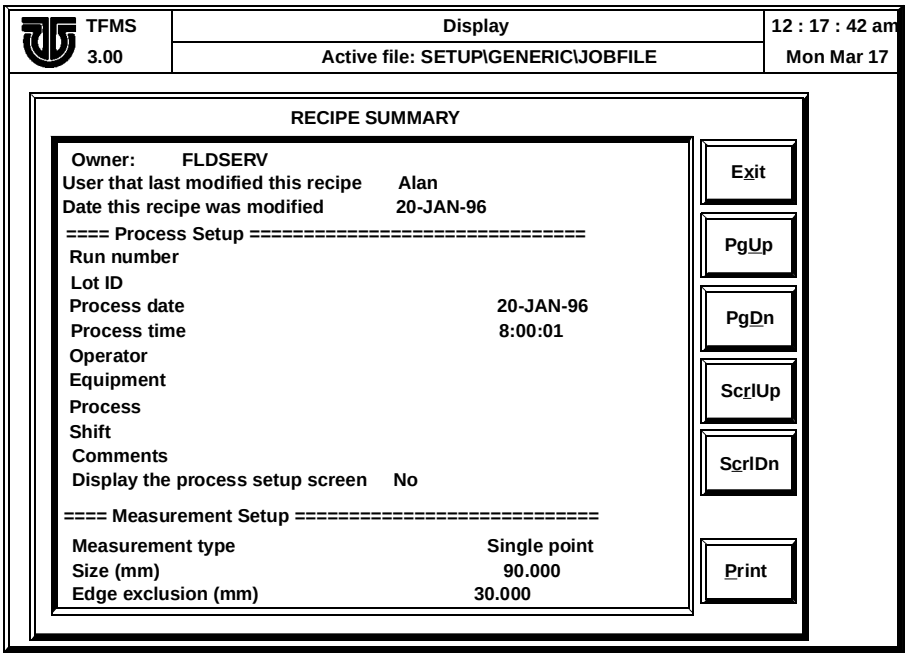


Display

When a job file is open and you select *Display*/*Recipe summary* /*Display*, the Recipe Summary window appears, as shown in Figure 2.54. This window displays

the active job file's recipe parameters and their current entries. The name and entry for each parameter is listed below the name of the recipe setup window where that parameter is entered (by an Engineer or higher level user). You use the *PgUp*, *PgDn*, *ScrlUp*, and *ScrlDn* buttons to move through the entire list. In a few cases, field names differ from their actual names and some of the longer names are abbreviated. This window is view-only and cannot be altered.

Figure 2.54 Recipe summary window



- ***PgUp, PgDn buttons:*** You use these buttons to move through the recipe summary list. Each page has 16 lines of information. You use the *PgUp* button to move up in the list, and the *PgDn* button to move down in the list.

- ***ScrlUp, ScrlDn buttons:*** You use these buttons to scroll up and scroll down in the list, one line at a time.

- ***File:*** When you select *Display*/*Recipe summary* /*File*, a dialog box tells you to insert a blank disk in the floppy drive. When you follow the directions in the dialog box and select *Ok*, the system copies the Recipe summary file to your floppy disk.

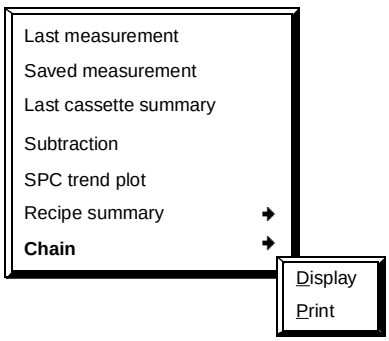
- ***Print:*** When you select *Display*/*Recipe summary* /*Print* , a dialog box appears that says: *Print Recipe Summary?* If you select *Ok,* the system prints a copy of the Recipe summary.

While the system sends the report to the printer, the screen is blank and a message appears in the Status area that says: Printing Recipe summary Report.

2.9.9 Chain

When you select *Display*/*Chain*, the Chain menu appears with two options, *Display* and *Print*, as shown in Figure 2.55.

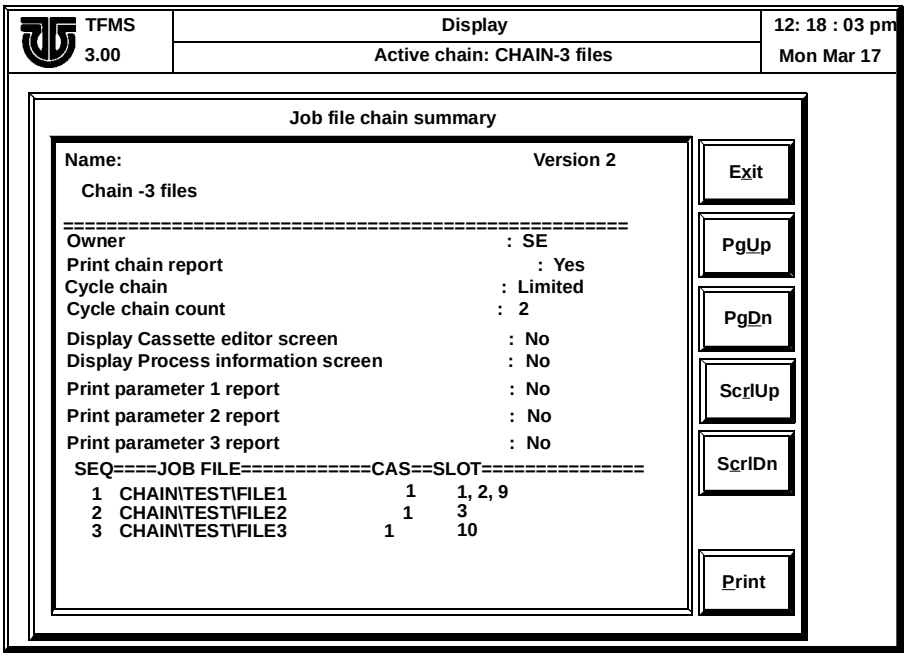
Figure 2.55 Chain menu



Display

When a job file chain is open and you select *Display*/*Chain*/*Display* , the Job file chain summary window appears with the active job file chain's parameters and current entries, as shown in the example in Figure 2.56. If no chain is active, a dialog box appears with a message informing you of this.

Figure 2.56 Job file chain summary window



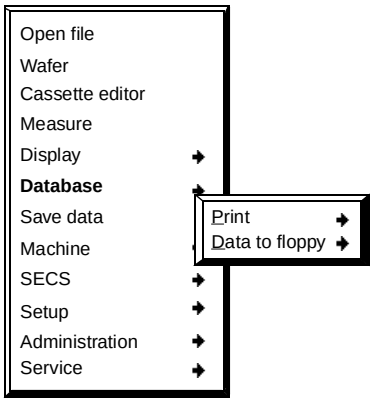
Print

When you select *Print* in the Chain menu, the system prints a copy of the Job file chain summary.

2.10 DATABASE

When you select *Database* in the Main menu, the Database menu appears listing two options, as shown in Figure 2.57. You must open a job file before you can use these functions, as described below.

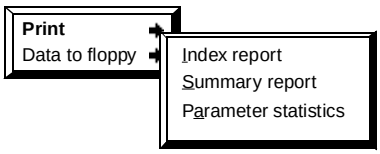
Figure 2.57 Database menu



2.10.1 Print

When you select *Main menu*/*Database* /*Print* , the Print menu appears, as shown in Figure 2.58. When you select any of the report options in this menu, the Select database range window appears, as shown earlier in this section (see *Display*/*Saved measurement)*. In this window, you enter the range of database records you'd like to include in the selected report. When you select the *Go* button, the system prints the report.

Figure 2.58 Print menu



Index report

The Index report's measurement record entries are similar to those in the Saved Measurement window, and the records appear in numerical order. If there are no measurement records saved in the active job file, a dialog box appears with a message that says: *There are no database records to print*. If you see this message, select *Ok* to close the dialog box.

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Summary report

The Summary report is similar to the Index report with the addition of the measurement type, number of points, wafer diameter, measurement size, layer 1, 2, and 3 films, substrate, and the parameter results averages.

Parameter statistics

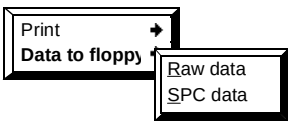
The Parameter statistics appear in display windows that look similar to the Last chain summary and Last cassette summary Parameter reports, described earlier in this section. These reports display the following information for each parameter: a list of means and other data that correspond 1 to 1 with each of the measurements displayed in the Summary report and the Sigma,% Sigma, Range,% Range, Max, and Min for the selected parameter for each wafer.

If you select any of the above options before opening a job file, the Open window appears. After you select a job file in the Open window, the system opens the job file, the Select database range window appears, and you can enter a range of records to print, as described above.

2.10.2 Data to floppy

When you select *Main menu*/*Database* /*Data to floppy*, the Data to floppy menu appears with two options, as shown in Figure 2.59. This function allows you to copy selected job file parameters, measurement data, and/or statistics from the database to a floppy disk.

Figure 2.59 Data to floppy menu

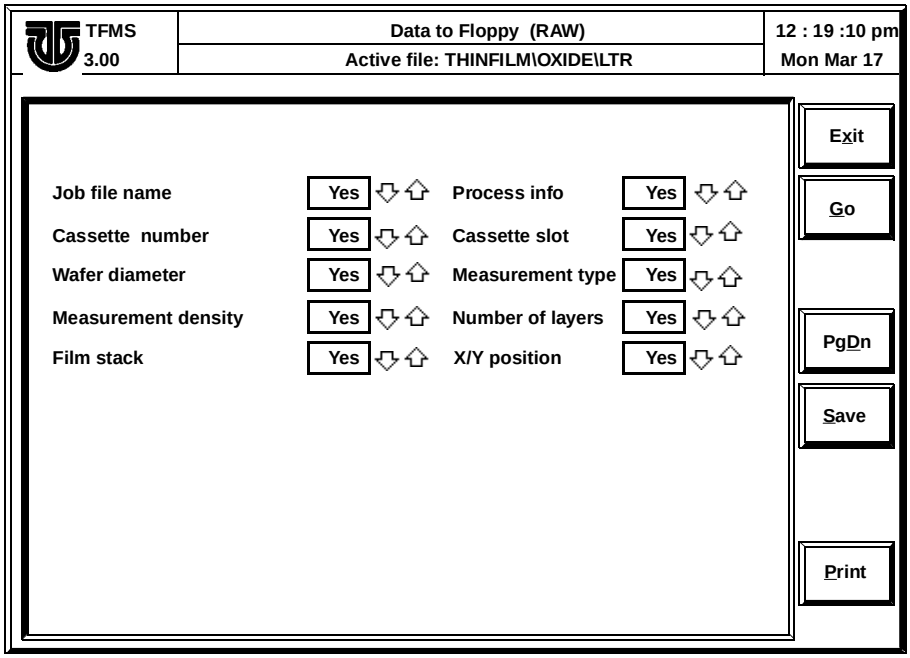


Raw data

If you select *Raw data* in the Data to floppy menu, the Data to floppy (Raw) window appears, with a list of the job file parameters that you can copy, as shown in the example in Figure 2.60. In this window, you can specify the parameter(s) you'd like to copy for selected database records. You select *Yes* if you want to copy

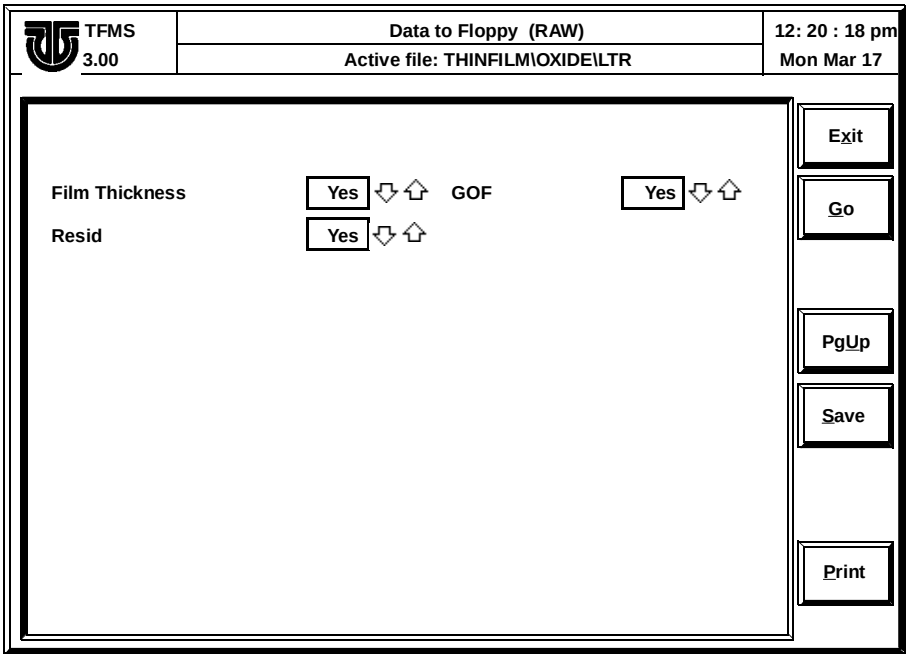
a parameter or *No* if you do not want to copy a parameter. If you'd like to save your selections, select the *Save* button in the right margin.

Figure 2.60 Data to Floppy (RAW) window



When you select the *PgDn* button in the Data to Floppy (Raw) window, the raw measurement data that you can copy appears, as shown in the example in Figure 2.61 (for a one parameter measurement). In this window, you select the raw measurement data that you'd like to copy for each measurement site in selected database records.

Figure 2.61 Data to Floppy (RAW) window (after selecting the *PgDn* button)



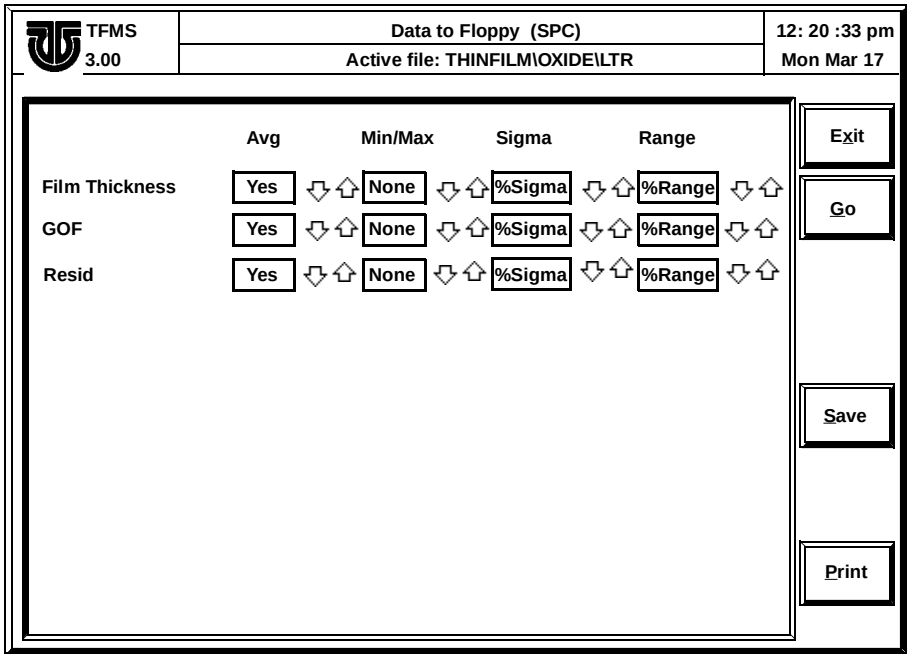
SPC data

When you select *Main menu*/*Database* / *Data to floppy*/*SPC data* , the Data to Floppy (SPC) window appears, displaying the SPC statistics that you can copy, as shown in the example in Figure 2.62. In this window, you specify the SPC statistics you'd like to copy for each wafer measurement in selected database record(s).

You can specify SPC statistics for each of the job file's measured parameters, as shown in the example in Figure 2.62. You can select from the following statistics for each measured parameter:

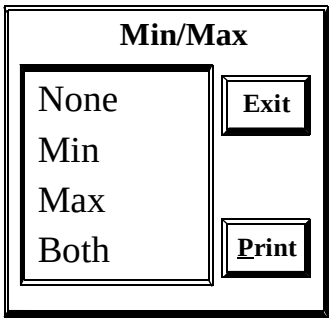
- ***Avg:*** You select *Yes* if you want to copy the Average statistics or *No* if you don't want to copy these statistics.

Figure 2.62 Data to Floppy (SPC) window



- ***Min/Max:*** When you select *Min/Max*, a pop-up menu appears with four options, as shown in Figure 2.63. You can select either *Min*, *Max*, or *Both* (Min and Max), to specify the statistic(s) you want to copy. You select *None* if you don't want to copy any of these statistics.

Figure 2.63 Min/Max pop-up menu



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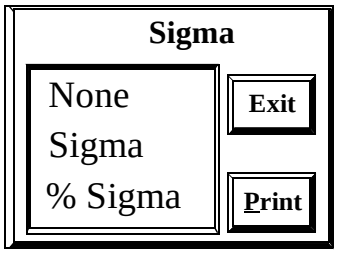
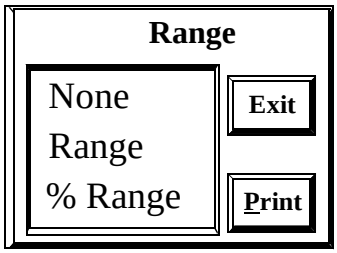
- ***Sigma:*** When you select *Sigma*, a pop-up menu appears with three options, as shown in Figure 2.64. You can select *Sigma* or *% Sigma* to specify the statistic you want to copy. You select *None* if you don't want to copy either of these statistics.

Figure 2.64 Sigma pop-up menu



- ***Range:*** When you select Range, a pop-up menu appears with three options, as shown in [1]. You can select Range or % Range to specify the statistic you want to copy. You select None if you don't want to copy either of these statistics.

Figure 2.65 Range pop-up menu

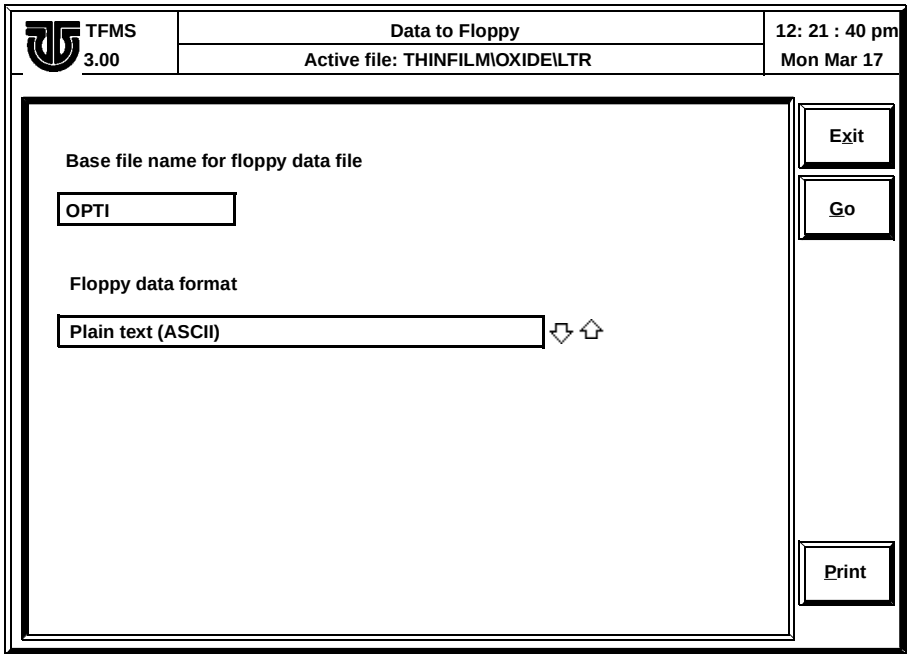


Go button

The *Go* button performs the same function in both the Raw data and SPC data windows. When you select the *Go* button in either of these windows, two fields appear, *Base file name for floppy data file* and *Floppy data format*, as shown in Figure 2.66.

1.

Figure 2.66 Data to Floppy window



Base file name for floppy data file

Specifies a name for a file on the floppy disk where the selected data is copied. If you change job files, the system continues copying all data to this Base file. The default Base file name is OPTI, as shown in Figure 2.66. The system automatically adds a .001 extension to this name. If you select this field, a keyboard window appears where you can change the name of this file. It must be a DOS-type file name without an extension. If you enter an invalid file name, a dialog box appears that reminds you of the correct format. If this happens, select *Ok* to close the dialog box, re-select the *Base file name for floppy data file* field, and enter a valid file name.

Floppy data format

Specifies the file format. When you select this field, a pop-up menu appears with two format options, as shown in Figure 2.67.

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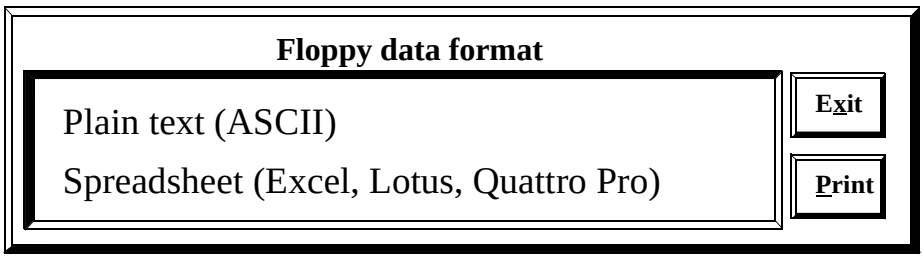
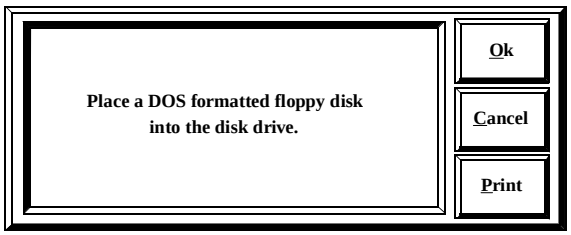
Figure 2.67 Floppy data format pop-up menu



The plain text format separates each piece of information by spaces and allots 23 characters for each field. The spreadsheet format saves the data in the Comma-Separated Value format, which you can import directly into spreadsheet applications.

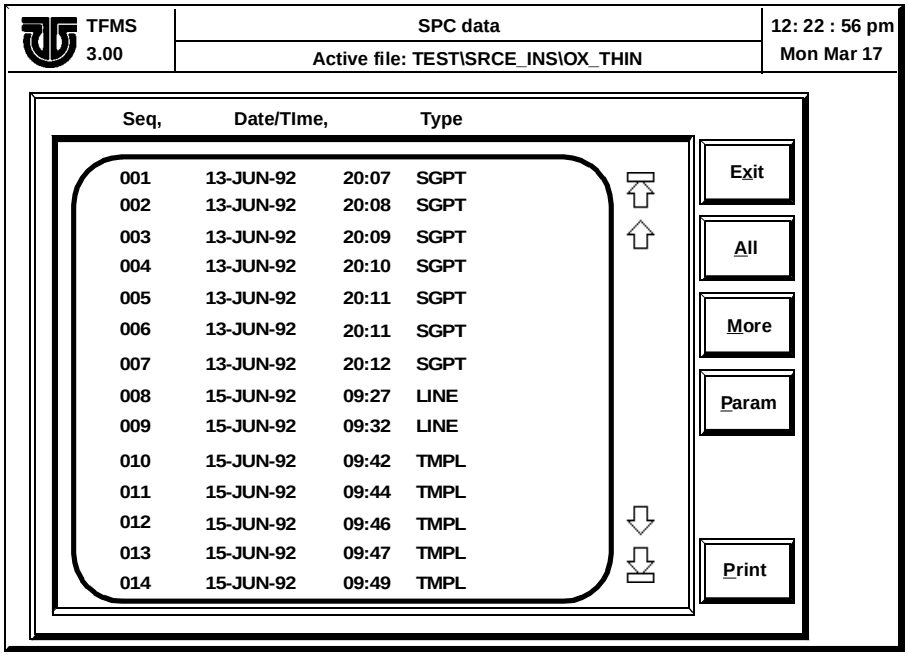
- ***Bug report:*** In some cases, the spreadsheet format does not function with Lotus. If you're using Lotus, call Therma-Wave Applications staff for assistance. After you make your entries, select the *Go* button again. You'll see a dialog box appear that tells you to place a DOS formatted floppy disk in the Opti-Probe's floppy drive, as shown in Figure 2.68. The floppy drive is located next to the tape drive, at the front of the Opti-Probe, beneath the keyboard.

Figure 2.68 Insert floppy disk dialog box



You insert a DOS formatted floppy disk and select *Ok* to continue, or select *Cancel* to cancel the operation. When you select *Ok*, the system verifies that the floppy disk is formatted, has the available file space, and the selected file isn't already saved to the floppy. If the system cannot verify these requirements, a dialog box appears that identifies the problem and allows you to cancel the operation. If you continue, the appropriate Database Selection window appears with a list of all measurements saved in the active job file, as shown in the example in Figure 2.69 for SPC data. This window looks similar to the Saved measurement window (shown earlier in this section), except for the addition of the *All* button.

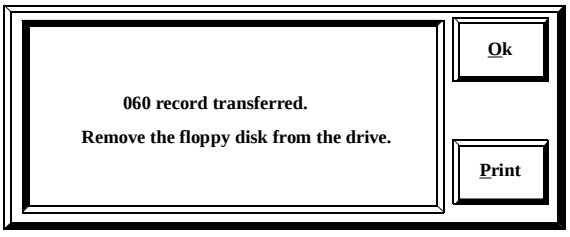
Figure 2.69 Database Selection window(SPC data)



Go button

You can select the database record(s) you'd like to copy to the floppy disk by selecting them one at a time. After you select the desired record(s), select the *Exit* button in the window's right margin. As the system writes each record to the floppy disk, the record's sequence number appears in the Status line. After the system copies all the records, the Database Selection window closes and a confirmation dialog box appears, as shown in Figure 2.70.

Figure 2.70 Record transferred dialog box



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All button

If you'd like to copy all of the database records to the floppy disk, select the *All* button. As the system writes each record, a Status line message identifies the record by sequence number. After the system copies all the records, the Database Selection window closes and a confirmation dialog box appears

More button

When you select the *More* button, the Select data base range window appears, as shown earlier in this section for *Display*/*Saved measurement*. You see a *Go* button in the right margin and two fields, *Ending record* and *Number of records*. You can display a range of records in the Database Selection window by making entries in these fields and then selecting the *Go* button. The default number of records that the system displays is either the total number of records saved in the database or the number entered by the System Manager in the System parameters window. For a very large database, a small default entry allows faster access to the job file and its database. You can temporarily override this default setting by entering a larger or smaller number of records in this window.

2.11 SAVE DATA

Typically, the *Main menu*/*Save data* option is non-selectable because most job files are set up to automatically save data. In addition, this option is also non-selectable if a job file is not open, the last measurement is already saved, or no measurement was made using the active job file. When a job file isn't set up to automatically save data, the *Save data* option is selectable. In this situation, you must select *Save data* immediately after performing a measurement to save that measurement's data in the active job file's database. If you display a previously saved measurement before using the Save data function, the system cannot save the most recent measurement.

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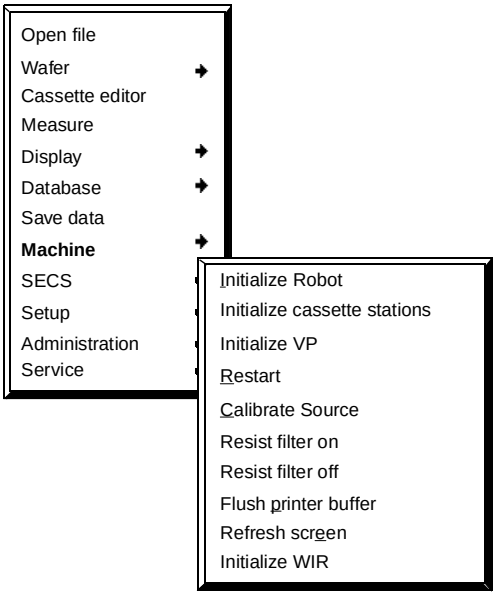
2.12 MACHINE

When you select *Machine* in the Main menu, the Machine menu appears, as shown in Figure 2.71.

Figure 2.71 Machine menu



2.12.1 Initialize Robot

When you select *Machine* /*Initialize Robot* , the system initializes the robot. You use this function when you're experiencing errors resulting from communication problems with the robot.

2.12.2 Initialize cassette stations (Bulkhead systems only)

When you select *Machine* /*Initialize cassette stations* on a bulkhead installation, the system initializes and checks communication with the bulkhead window flipper controller, sets the window timeout, and enables the window's manual open/close button.

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2.12.3 Initialize VP (VP systems only)

When you select *Machine* /*Initialize VP*, the vision processor boots and initializes. You use this function when you're experiencing errors resulting from communication problems with the vision processor. This option is only selectable on systems with a vision processor installed.

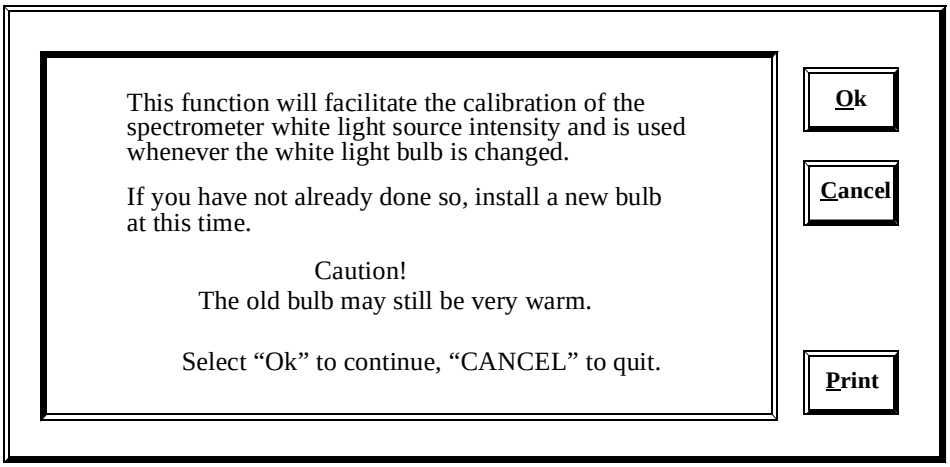
2.12.4 Restart

When you select *Machine* /*Restart*, the system performs a complete initialization of the hardware followed by a Selftest. While the system initializes, you see a series of messages appear in the Status line identifying the part of the hardware being initialized. You return to the Machine menu after the Restart is completed.

2.12.5 Calibrate Source

This option activates the white light source intensity calibration operation. When you select *Machine*/*Calibrate Source*, a dialog box appears explaining that you should perform this procedure whenever you change the white light bulb, as shown in Figure 2.72.

Figure 2.72 Calibrate Source dialog box


This function will facilitate the calibration of the spectrometer white light source intensity and is used whenever the white light bulb is changed.
If you have not already done so, install a new bulb at this time.
Caution!
The old bulb may still be very warm.
Select “Ok” to continue, “CANCEL” to quit.
Ok
Cancel
Print

Before you proceed with this operation, make sure you have the following items:

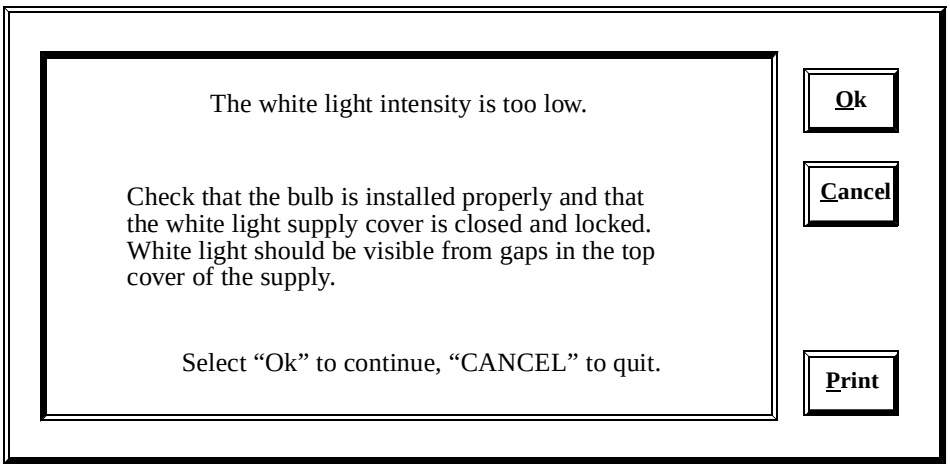
- Replacement white light bulb
- Tool for opening the front panel of the Opti-Probe
- Small flat-blade screwdriver

Your training should include instructions for opening the front panel of the Opti-Probe and changing the white light bulb. If you have any questions, consult your System Manager. If you'd like to cancel the operation, select the *Cancel* button in the dialog box. If you'd like to proceed, open the front panel, replace the light bulb, and then select the *Ok* button in the dialog box.

The screen blanks and the system positions the internal reference sample under the objective lens. Then the system focuses on the reference and checks the white light intensity. If the intensity is too low, a message appears that explains what to do, as shown in Figure 2.73.

2.12.6 Calibrate Source

Figure 2.73 Low intensity dialog box


The white light intensity is too low.
Check that the bulb is installed properly and that the white light supply cover is closed and locked. White light should be visible from gaps in the top cover of the supply.
Select “Ok” to continue, “CANCEL” to quit.
Ok
Cancel
Print

If you'd like to cancel the operation, select the *Cancel* button in the dialog box. If you'd like to proceed, re-install the light bulb and select the *Ok* button in the dialog box.

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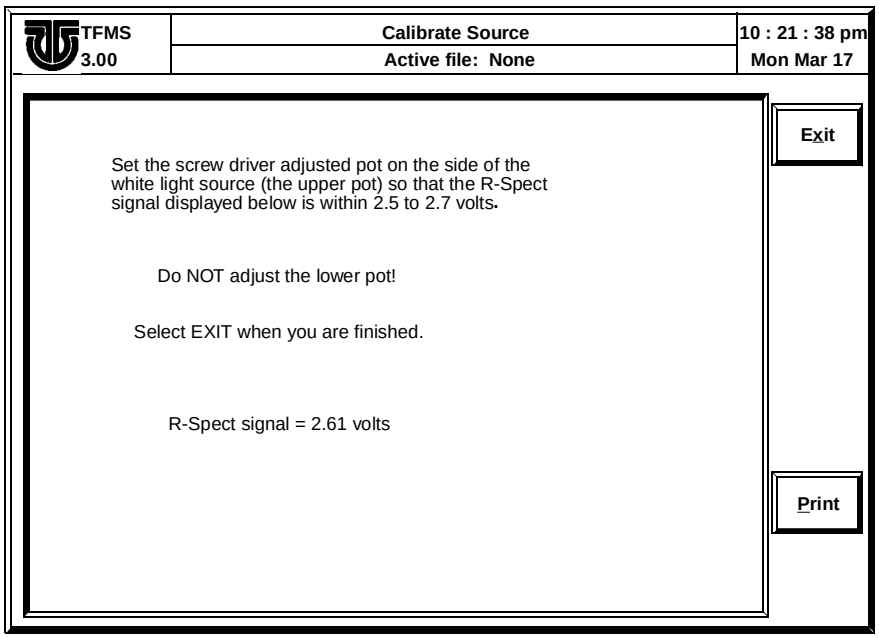
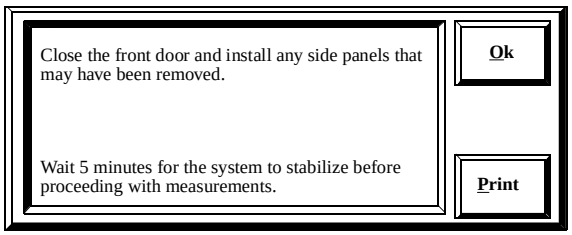
If the system detects sufficient white light intensity, some measurements are made on the reference using the Opti-Probe spectrometer. These measurements take approximately 20 seconds. The Calibrate Source window appears with instructions on how to adjust the white light intensity, as shown in Figure 2.74.

Figure 2.74 Calibrate Source window


TFMS
3.00
Calibrate Source
Active file: None
10 : 21 : 38 pm
Mon Mar 17
Exit
Set the screw driver adjusted pot on the side of the white light source (the upper pot) so that the R-Spect signal displayed below is within 2.5 to 2.7 volts.
Do NOT adjust the lower pot!
Select EXIT when you are finished.
R-Spect signal = 2.61 volts
Print

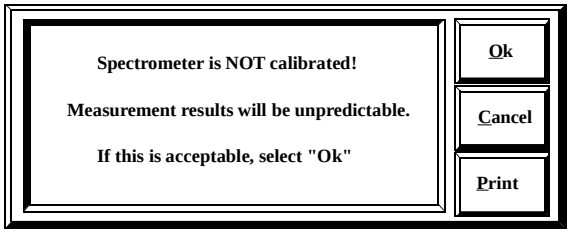
As you adjust the upper pot (labeled HIGH) with the screwdriver, the R-spect signal is continuously updated. When the signal reads between 2.5 and 2.7 volts, select the *Exit* button. A dialog box appears with instructions on how to close up the system and let it stabilize, as shown in Figure 2.75.

Figure 2.75 Complete calibration dialog box


Close the front door and install any side panels that may have been removed.
Wait 5 minutes for the system to stabilize before proceeding with measurements.
Ok
Print

If you close the Calibrate Source window and the signal is not between 2.8 and 3.0 volts, a warning dialog box appears, as shown in Figure 2.76.

Figure 2.76 Calibrate Source warning dialog box



If you select *Cancel*, the Calibrate Source window reappears and you can make additional adjustments. If you select *Ok*, the Complete calibration dialog box appears, as shown in Figure 2.75. Whenever you calibrate the white light source, the system performs a System test before the next wafer measurement.

If the system fails the white light source calibration, Therma-Wave recommends that you do not perform measurements that utilize the spectrometer. You can still perform non-spectrometer measurements. Call Therma-Wave for assistance.

2.12.7 Resist filter on, Resist filter off

These options are only accessible at the System Expert and System Manager levels. At the Operator level, *Resist Filter on* and *Resist Filter off* are non-selectable and appear in blue in the Machine menu. For a detailed description of these options, see Section 6 , "System Expert Functions."

2.12.8 Flush printer buffer

If the printer was disconnected or is in the stand-by mode and you select *Machine*/*Flush printer buffer*, the system cancels the printing of any documents in the Opti-Probe's printer buffer and you can print immediately. This does not affect the printer's internal buffer.

2.12.9 Refresh screen

When you select *Machine*/*Refresh screen*, the system closes any open menus, re-draws the screen, and displays only the Main Menu screen.

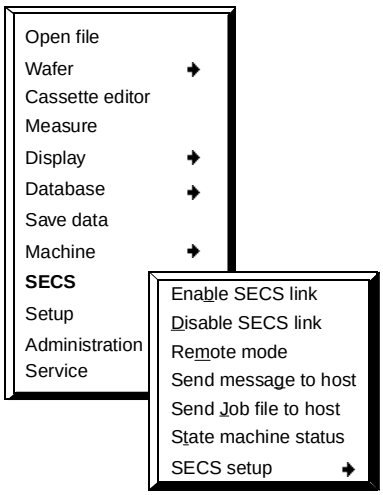
2.12.10 Initialize WIR (Wafer Imprint Reader systems only)

When you select *Machine*/*Initialize WIR*, the system initializes the Wafer Imprint Reader (WIR). This option is only accessible on WIR equipped systems. You use this function if you're experiencing problems with the WIR.

2.13 SECS

SECS (SEMI Equipment Communication Standard) defines a computer-to-computer communications interface between a unit of factory equipment and a host computer. If your system has the necessary SECS hardware and software installed, the *SECS* option appears in white and is selectable; otherwise it appears in blue and is non-selectable. When you select *SECS* in the Main menu on a SECS equipped system, the SECS menu appears, as shown in Figure 2.77. For a description of the SECS menu options, see the separate "SECS II Manual."

Figure 2.77 SECS menu



2.14 SETUP

Users logged in at the Engineer, System Expert, or System Manager level can access the Setup menu functions described in Section 3, "Engineer Functions." In addition, System Managers can grant Operator level users limited access to the Setup menu by creating a restricted Engineer level User ID. For more information on setting up a limited access User ID, see Section 7 "System Manager Functions."

2.15 ADMINISTRATION

Users logged in at the System Manager level can access the Administration menu functions described in Section 7, "System Manager Functions."

2.16 SERVICE

Therma-Wave personnel can access the Service function.

3

ENGINEER FUNCTIONS

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- Library menu 3-141
- Chain menu 3-153

In this section, you'll learn about the Opti-Probe's Engineer functions. To access these functions, you must have Engineer, System Expert, or System Manager privileges. At this level of TFMS, authorized users create and manage job filesand configure recipes, which specify film, measurement, cassette and wafer handling, and other job file parameters. After an authorized user creates a job file, an operatorcan open it to measure wafers and view data. For more information on Operator functions, see Section 3, "Operation Summary." The Opti-Probe's display parameters, output controls, and test functions are also controlled at the Engineer level.

In some cases, a System Manager may remove Engineer level access to the Film recipe and/or related library functions. If you try to use these functions and do not have the necessary access privileges, a message informs you of this.

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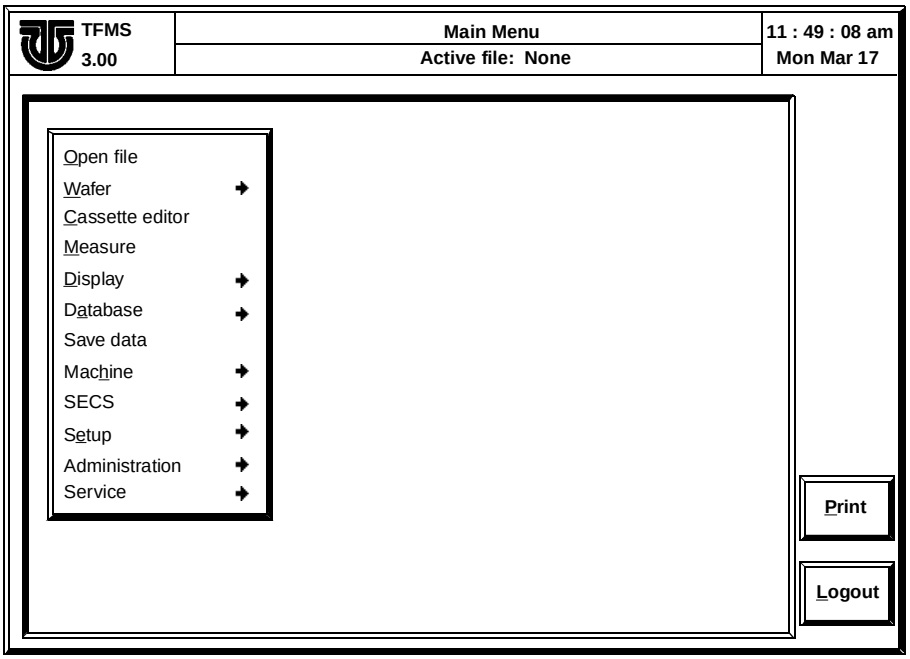
3.1 MAIN MENU WINDOW

When you log into the system with an Engineer level User ID the Main Menu window reappears in a different color that identifies the Engineer level. A *Logout* button appears in the window's right margin, as shown in Figure 3.1. For a description of the login procedure, see your "Getting Started" manual."

Figure 3.1 Main Menu window (Engineer level)



3.2 MAIN MENU

Your Engineer level User ID allows you to select the *Setup* option in the Main menu in addition to the *Open file*, *Wafer*, *Cassette editor*, *Measure*, *Display*, *Database*, *Machine*, and *SECS* (if installed) Operator level functions. These options appear in white text, while the non-selectable Main menu options appear in blue text. This section describes all the Setup menus, windows, and functions.

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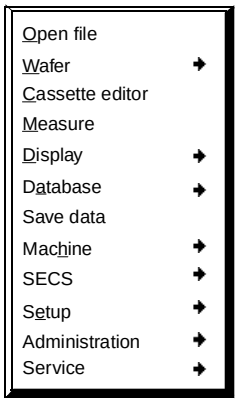
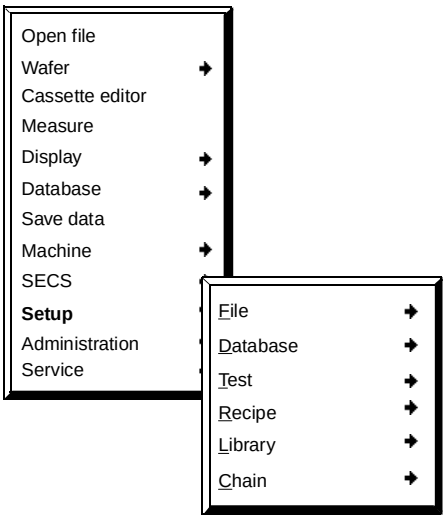
Figure 3.2 Main menu (Engineer level)



3.3 SETUP MENU

The Setup menu is at the top of the Engineer level menu hierarchy. When you select *Setup* in the Main menu, the Setup menu appears with a list of options, as shown in Figure 3.3.

Figure 3.3 Setup menu



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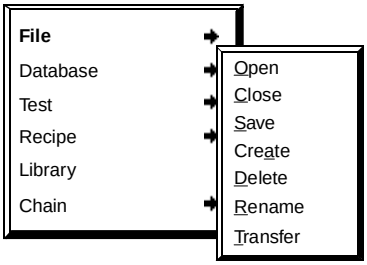
3.4 FILE MENU

When you select *Setup*/*File*, the File menu appears, as shown in Figure 3.4. The File menu lists seven job file management functions.

Figure 3.4 File menu



3.4.1 Open

The Open function in the File menu is identical to the Open file function in the Main menu.

When you select *Setup*/*File*/*Open* , the Open window appears with a list of directories. You see the first directory highlighted in light green, with any other directories listed below it.

Three components define an Opti-Probe job file path: directory, sub-directory and job file. A directory is the highest level of the Opti-Probe file system and contains one or more sub-directories. A sub-directory contains one or more job files. You can select any job file to make it the active job file. You can use the active job file to measure wafers or view data saved in its database.

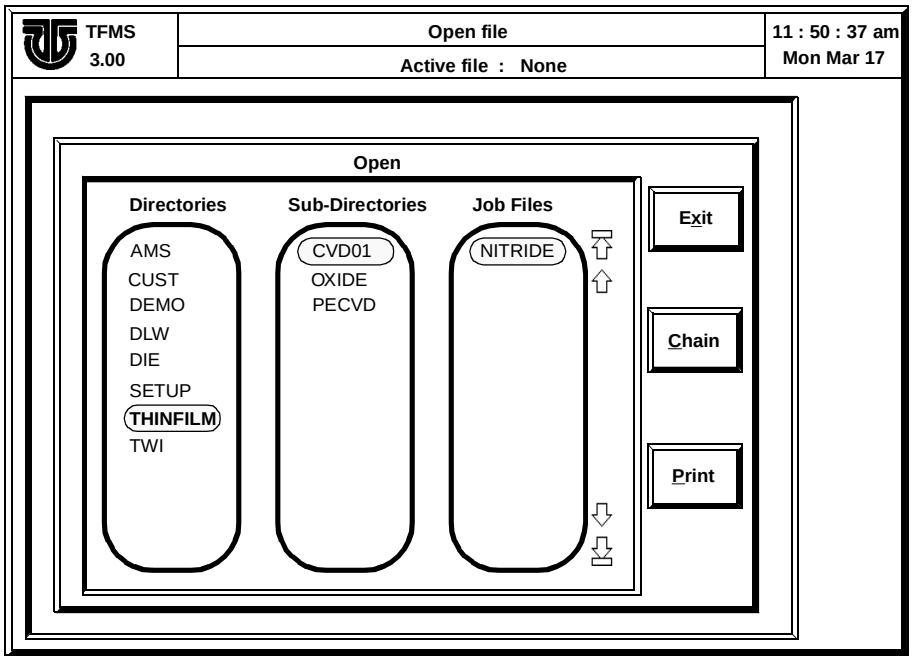
You can browse through the list of directories with the light pen and select the appropriate one. You see the selected directory highlighted in dark green to show it is part of the current job file path. A list of sub-directories appears, and you see the first sub-directory highlighted in light green. You select a sub-directory and then a job file the same way you selected a directory.

After you select a directory and a sub-directory, the Open window looks like the example in Figure 3.5. After you select (open) a job file, its name appears as the Active file in the Main Menu window Status area.

The Opti-Probe's hard disk stores all job file recipes on one partition, and all vision files (on systems with a vision processor [VP]) on another partition. If either of

these partitions is more than 90% full, a dialog box appears with a message while the job file is opening. When you see this message, select *Ok* to close the dialog box and inform your System Manager that it is time to delete old job files and measurement data. When the recipe partition is about 95% full, you cannot save data or create new job files.

Figure 3.5 Open window (after selecting a sub-directory)



Chain button

When you select the *Chain* button in the Open window, the Select a job file chain window appears, as shown in Figure 3.6. In this window you can select a job file chain. Job file chaining allows you to perform automated wafer measurements that use multiple recipes from different job files. The system runs the desired job files in sequence for each of the selected wafers, and measures these wafers in their slot sequence for the most time efficient measurements. Each job file chain is saved in a Job file chain library and its ownership is secured like individual job files. When you select a job file chain, its name appears as the Active chain in the Status area.

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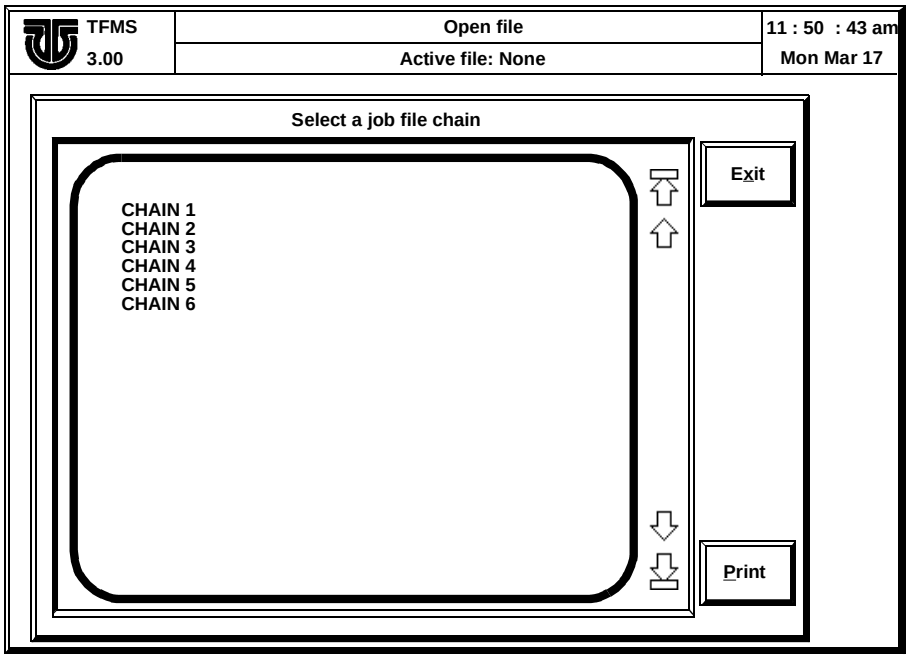
Figure 3.6 Select a job file chain window



3.4.2 Close

Makes the current job file inactive. All parameters are reset to the Opti-Probe's default values and the Active file appears as *None* in the Status area. If you have change privileges for a job file and you select *Close* after modifying any parameters, a confirmation dialog box appears asking if you want to save your changes.

3.4.3 Save

Saves **all** changes made to the active job file. If you have change privileges for a job file and you select *Save* after changing any film parameters, a Status line message says: *Searching for matching film library entry.* If the same film setup isn't already saved in the Film library, another Status line message says*: Creating new film library entry.* For more information on film parameters and the Film library, see *Setup*/*Recipe*/*Film* and *Setup*/*Library*/*Film*, later in this section.

Later in this section, you'll see a Save button in the right margin of most of the data entry window figures. When you select one of these buttons, any setup changes you've made in the current window are saved in the active job file. These Save buttons only save setup changes made in their respective windows.

3.4.4 Create

When you select *Setup*/*File*/*Create* , the Create window appears, as shown in Figure 3.7. It looks similar to the Open window, with an *Enter* button instead of a *Chain* button in the right margin. When none of your existing job files are adequate for a required measurement, you can create a new job file in this window. You can create any number of job files, limited only by the storage capacity of your Opti-Probe's hard drive.

When you create a new job file using the *Create* function, you become the sole owner of the job file. Only you or someone with a higher privilege (e.g., System Expert, System Manager, or Therma-Wave personnel) can save changes to your recipe or delete data associated with your job file. This feature provides protection among the many users of each Opti-Probe. In some cases, the System Manager may allow other Engineer level users to save changes to your job file.

To create a new job file, you begin by opening (activating) an existing job file that contains a similar recipe to the one you'd like to use in your new job file. You create a new job file in the Create window by copying the active job file and giving it a new name. After creating the new job file, you can modify its recipe to meet your current measurement requirements. In some cases, you may not want to start with one of the existing job files. Because it is not advisable to begin with "None" as the active file, Therma-Wave provides a generic job file (*SETUP\GENERIC\JOBFILE*). You can open this generic job file (instead of None) and copy it under a different name before entering and saving the desired modifications.

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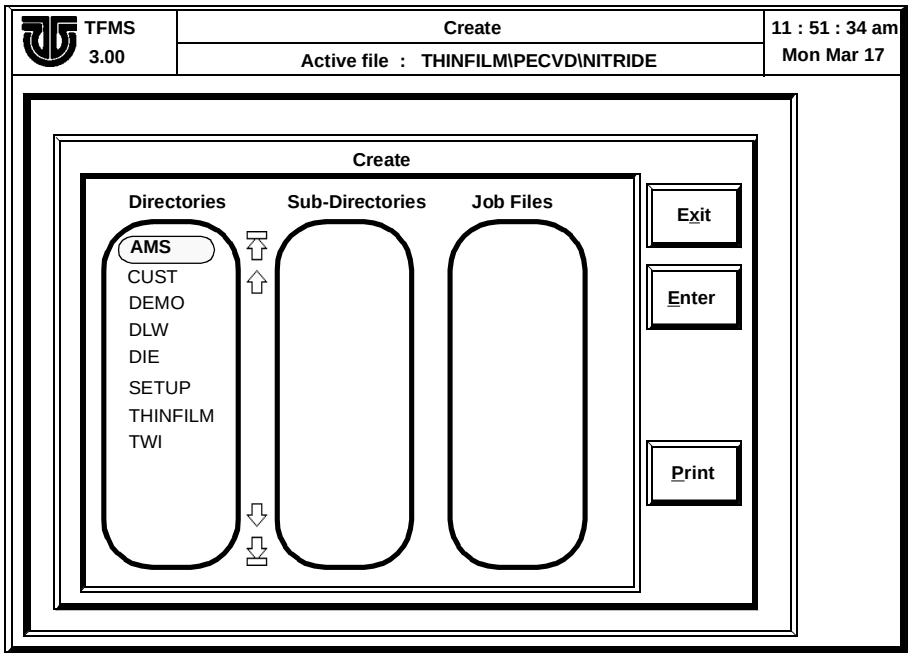
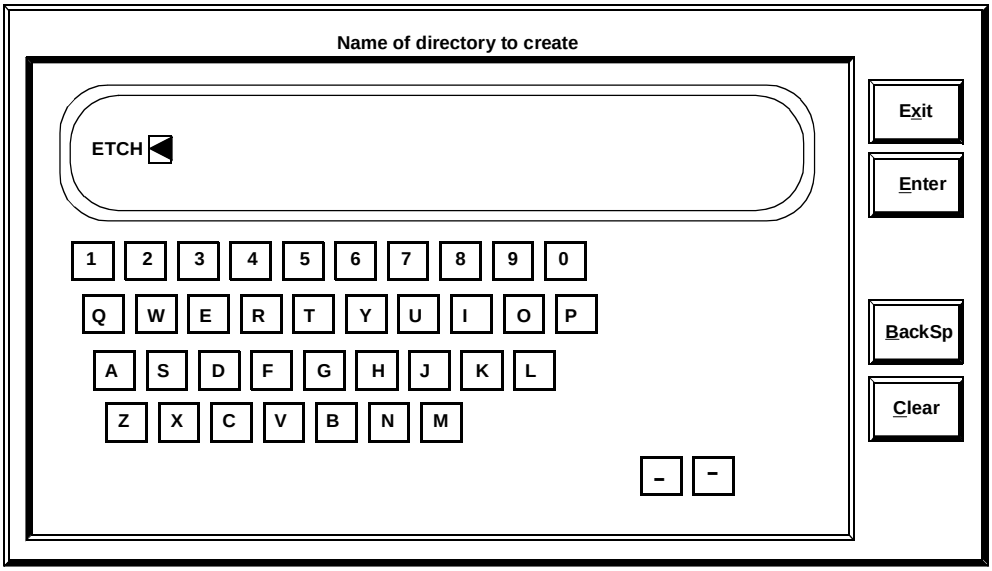
Figure 3.7 Create window



You can create a new directory for the new job file, or you can save it in an existing directory.

You create a new directory by selecting the *Enter* button instead of an existing directory name. A keyboard window appears, as shown in Figure 3.8, where you type the name of the new directory with the light pen, and then select the *Enter* button in the keyboard window's right margin.

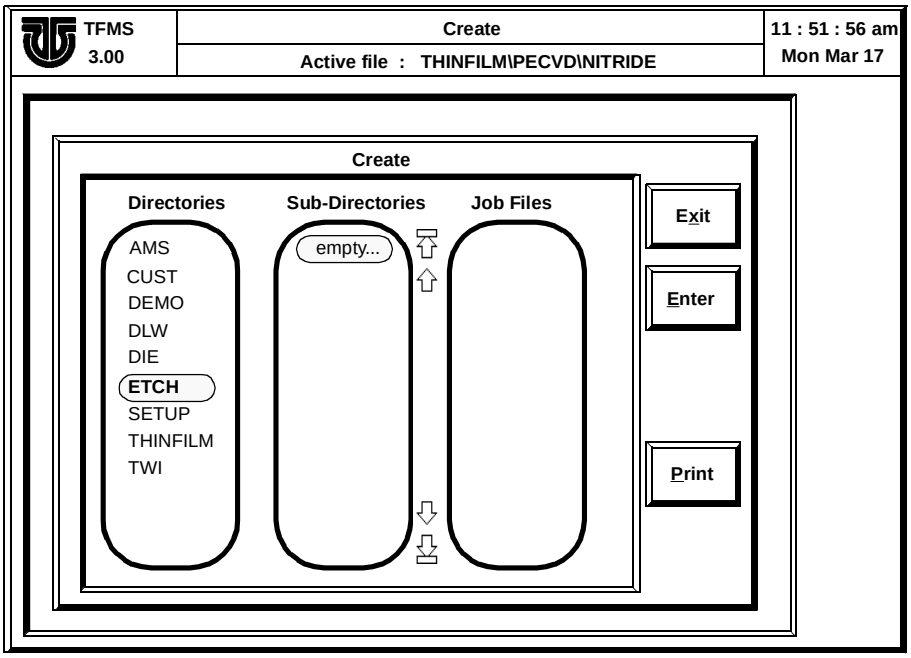
Figure 3.8 Create keyboard (create a new directory)



You see the new directory name listed in the Directories field, highlighted in dark green. An "empty..." sub-directory appears in the Sub-Directories field, highlighted in light green, as shown in Figure 3.9.

The active level in the job file path is always the next field on the right side of your highlighted (dark green) selection. In the example in Figure 3.9, the selected directory is "Etch" and the active level in the job file path is sub-directories. If the active level in the job file path contains an "empty..." listing, you must select the *Enter* button to open the keyboard window, and enter a name for this listing. You create new sub-directory and job file names by following the above steps for creating a new directory name. The keyboard window's title bar always identifies the active level in the job file path, as shown in Figure 3.8.

Figure 3.9 Create window (after creating a new directory)



Instead of creating a new directory, you can save the new job file in an existing directory by selecting that directory. You see the selected directory name highlighted in dark green, and its sub-directories appear in the Sub-Directories field.

You can save the new job file in an existing sub-directory by selecting that sub-directory. You see the selected sub-directory name highlighted in dark green, and its existing job files appear in the Job Files field. You can also create a new sub-directory for the new job file, as described above.

After creating a new sub-directory, or selecting an existing one, you create the new job file. You do this by selecting the *Enter* button and entering a name for the new job file in the keyboard window.

You cannot create a new job file by overwriting an existing one using the same name. This feature distinguishes the *Create* function from the standard "Windows" Save as operation. In TFMS, you must rename or delete the original job file before you can re-use its name.

When you enter a name for the new job file in the keyboard window, you save all the necessary information in this job file, and it becomes the active job file.

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Measurement results saved in the original job file's database do **not** get copied to the new job file's database. At this point, the new job file contains the same recipe parameters as the previously active job file. You can change the new job file's recipe parameters by following the data entry procedures discussed under "Recipe" later in this section.

If you'd like to return to a previous level (field) in the job file path, select any entry in the corresponding field. You see the name of your selection highlighted in light green, and the dark green highlighting disappears from the previous selection. At this point, you can make your selection, as described above.

You can close the Create window at any time and return to the File menu by selecting the *Exit* button in the window's right margin.

3.4.5 Delete

When you select *Setup*/*File*/*Delete* , a Delete window appears which looks like the Create window in Figure 3.7(except for the window title line). In this window, you can delete a job file, sub-directory, or an entire directory if you own all of the job files contained in that directory.

You delete a job file by selecting the desired job file path and then selecting the *Enter* button in the window's right margin. A dialog box appears with a message saying: *Ok to delete job file DIR\SUB\JOB?* Select the *Ok* button in the dialog box to delete the job file, or the *Cancel* button to exit without deleting.

You delete a sub-directory by selecting the appropriate directory and sub-directory names, and then the *Enter* button. If the sub-directory contains job files, a message appears saying: *Sub-directory DIR\SUB is not empty. Ok to delete?* When you select the *Ok* button, you delete the sub-directory and all its job files. If the sub-directory is empty, no message appears. If you delete each job file one at a time, the sub-directory remains in the directory with no job files.

Deleting a directory is similar to deleting a sub-directory. If a directory is not empty, you delete all its sub-directories and job files.

If you attempt to delete a job file path included in the Active file name, a confirmation message appears. For example, if the active job file is DIR\SUB\JOB and you attempt to delete the sub-directory SUB, the message says: *DIR\SUB is the active sub-directory. Ok to delete?* If you select the *Ok* button, the active job file closes (see *Close* above) before the system deletes the sub-directory.

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You cannot delete or rename (see "Rename" below) a job file unless you have the required change privileges. For more information on job file security, see your "Getting Started" manual. To delete or rename a directory or sub-directory, you must have the required change privileges for all of the job files contained within it. In some cases, you may have change privileges for some, but not all, of the job files. In this situation, you cannot rename the directory or sub-directory, and can only delete those files for which you have change privileges.

3.4.6 Rename

When you select *Setup*/*File*/*Rename* , a Rename window appears, which is similar to the Create window in Figure 3.7 (except for the window title line). In this window, you can rename an existing directory, sub-directory, or job file.

You rename a job file by selecting the desired job file path, and then the *Enter* button in the window's right margin. A keyboard window appears similar to the one in Figure 3.8 saying: *Enter new name for job file FILE in sub-directory DIR\SUB.* You type the new job file name with the light pen, and then select the *Enter* button in the keyboard window. You rename a sub-directory or directory by following the same steps.

If you attempt to rename a job file path included in the Active file name, a confirmation message appears when the keyboard window closes. For example, if the active job file is DIR\SUB\FILE and you attempt to rename the sub-directory (SUB), the message says: *DIR\SUB is the active sub-directory. Ok to rename?* If you select the *Ok* button, the new sub-directory name appears in the Status area.

You cannot rename a job file and move it into a different directory or sub-directory. Similarly, you cannot rename a sub-directory and move it into a different directory. You can use the *Transfer* function (described next) to perform these and other operations.

You can close the Rename window at any time and return to the File menu by selecting the *Exit* button in either the Rename window or the keyboard window.

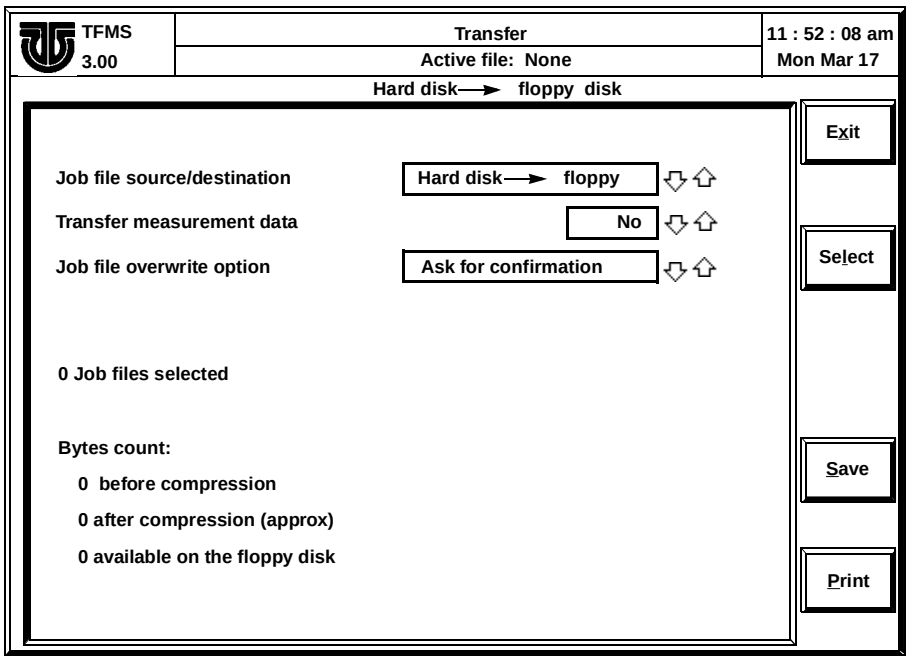
You cannot rename a directory, sub-directory, or job file unless you have the required change privileges, as explained above under "Delete."

3.4.7 Transfer

When you select *Setup*/*File*/*Transfer*, the Transfer window appears. If a job file is open, the system closes it before opening this window (a dialog box asks if you want to save any changes if you have change privileges).

In this window, you can copy directories, sub-directories and/or job files from one Opti-Probe to another Opti-Probe via floppy disks. You can also copy job files from one directory or sub-directory to another on the same Opti-Probe hard disk. The example in Figure 3.10 shows the Transfer window after selecting *Hard disk → floppy* in the *Job file source/destination* field.

Figure 3.10 Transfer window (Hard disk → floppy)



Job file source/destination

Specifies the source disk (copy from) and the destination disk (copy to). A pop-up menu appears with three options, as shown in Figure 3.11.

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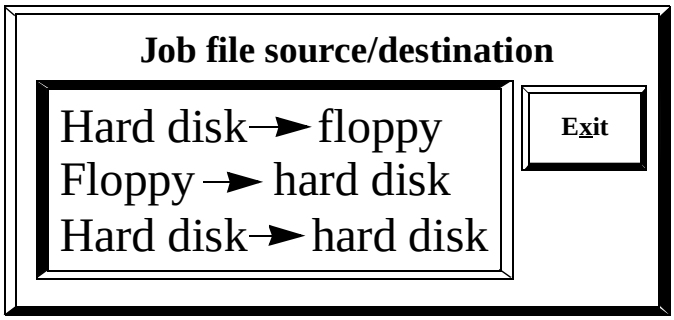
Figure 3.11 Job file source/destination pop-up menu



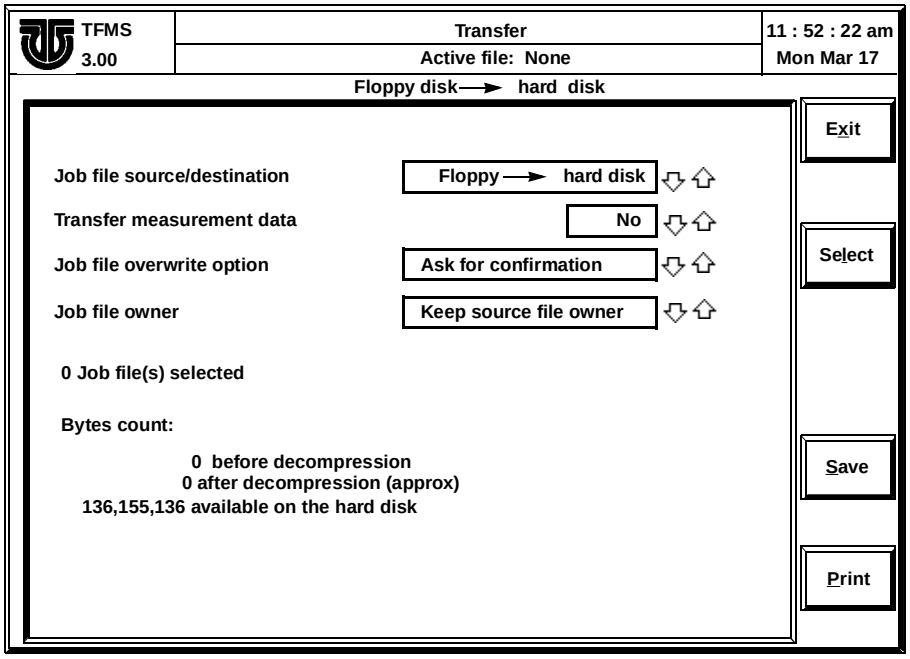
Hard disk → floppy: Copies the desired job file(s) from the Opti-Probe's hard disk to one or more floppy disks.

Floppy → hard disk: Copies the desired job file(s) from one or more floppy disks to the Opti-Probe's hard disk.

Hard disk → hard disk: Copies the desired job file(s) from one directory or sub-directory to another on the same Opti-Probe.

When you select either *Floppy → hard disk* or *Hard disk → hard disk*, the Transfer window re-appears with a new field, *Job file owner*, and the bytes count now includes the available space on the destination hard disk. The example in Figure 3.12 shows the Floppy disk → hard disk Transfer window. The Hard disk → hard disk Transfer window does not display compression/decompression information but shows the total bytes count instead.

Figure 3.12 Transfer window (Floppy disk → hard disk)



Transfer measurement data

Specifies whether or not to transfer the measurement data saved in each job file's database along with the selected job file(s).

Job file overwrite option

Specifies whether or not the system overwrites (deletes) any existing job files that are stored on the destination disk or displays an overwrite confirmation box before the copying process. A pop-up menu appears with three options, as shown in Figure 3.13.

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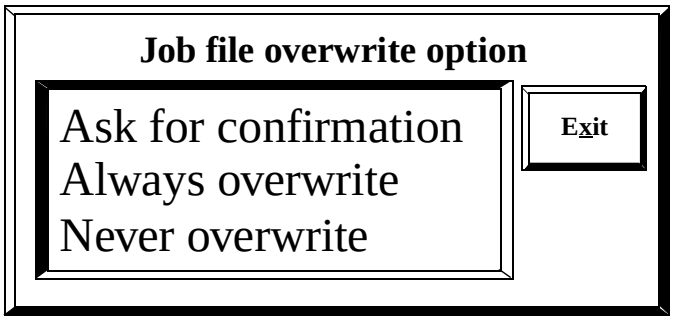
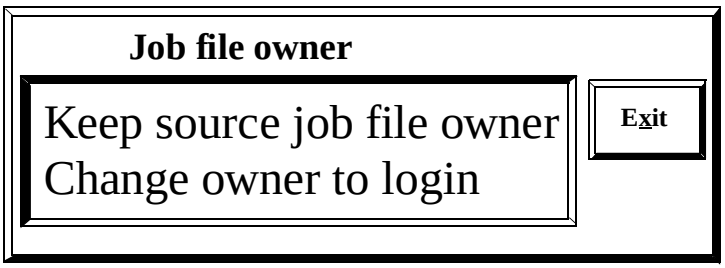
Figure 3.13 Job file overwrite option pop-up menu



Job file owner

Specifies either a change in job file ownership to the currently logged in user, or retention of the original (or source) job file owner. This field only appears when you select *Floppy → hard disk* or *Hard disk → hard disk.* Two options appear in a pop-up menu, as shown in Figure 3.14.

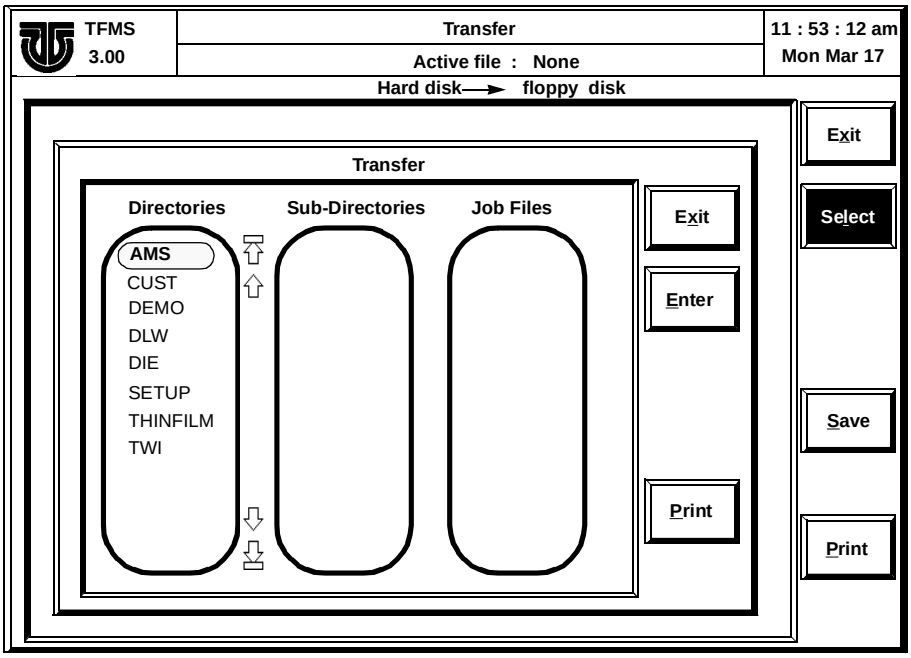
Figure 3.14 Job file owner pop-up menu



Select button

When you select this button, the Job File Transfer window appears, which looks similar to the Create window, as shown in Figure 3.15. In this window, you can select a directory, sub-directory, or job file to copy. When you're transferring from a hard disk, all the directories on that system appear. If you're transferring from a floppy disk, all the directories on that floppy appear, but first you see a dialog box that says: *Please insert floppy disk with job files into floppy disk drive.* The Job File Transfer window appears after you insert your floppy disk and select *Ok* in the dialog box.

Figure 3.15 Job file transfer window



Enter button

When you select the job file path and then the *Enter* button, the Transfer window re-appears, as shown in the examples in Figures 3-16 and 3-17. It displays the number of job files selected and the number of bytes in the selected job file(s) both before and after data compression or decompression. The system compresses job files copied to floppy disks and decompresses job files copied from floppy disks to the Opti-Probe's hard disk. Hard disk to hard disk transfers do not require compression or decompression and display the total bytes count.

For transfers to the hard disk, the available space on the Opti-Probe's hard drive appears along with one, two, or three new fields for the destination job file path, as shown in Figure 3.17. The number of fields corresponds to the selected job file path, e.g., if you only select a directory it reads: *Please enter destination directory.* When you select these fields, a keyboard window appears where you can enter the desired job file path names. You must make entries in these fields; if you do not, a dialog box prompts you for your entry.

In addition, *Copy* and *Clear* buttons now appear in the window's right margin.

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Figure 3.16 Transfer window after selecting job file path (Hard disk → floppy)

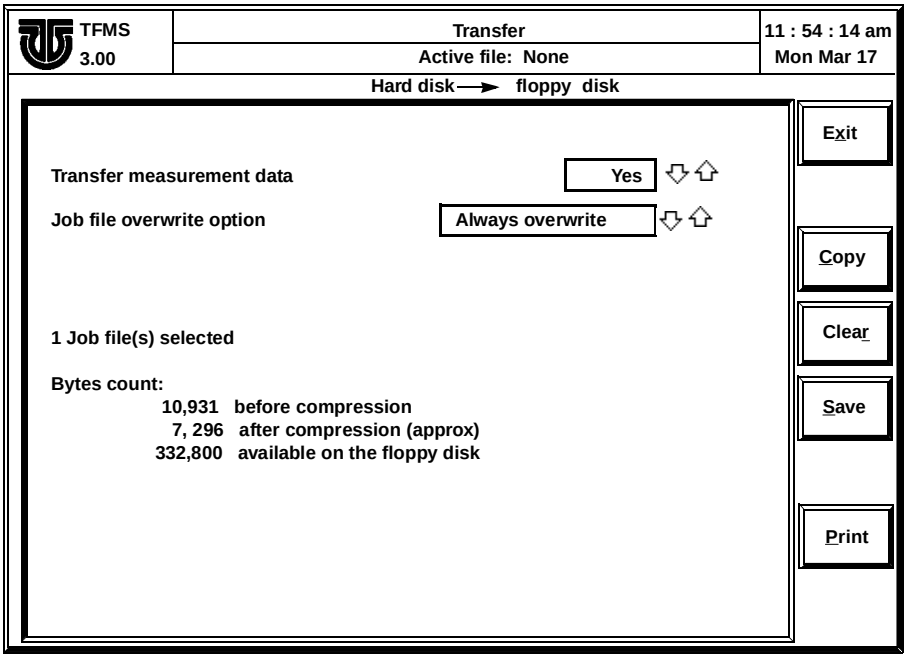
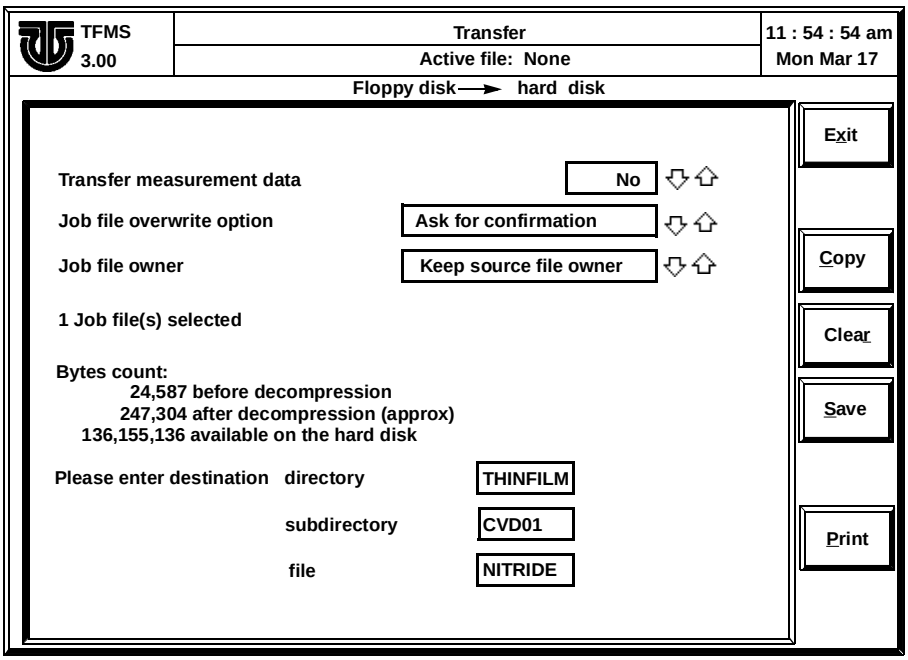


Figure 3.17 Transfer window after selecting job file path (Floppy → hard disk)



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Clear button

When you select the *Clear* button, you cancel (clear) the job files selected during the Select operation. This feature allows you to change your selection. At this point, you return to the window in Figure 3.10 or 3-12 with the *Select* button displayed instead of the *Copy* and *Clear* buttons. You must now perform the Select operation again before copying the desired job files, as explained below.

Copy button

When you select the *Copy* button, the system copies the selected directory(s), sub-directory(s), and/or job file(s), as described next for each of the source/destination options.

Hard disk → floppy: If you're copying job files from the Opti-Probe's hard disk to a floppy disk, a dialog box appears that says: *Please insert a formatted floppy disk into floppy disk drive*. If you insert a DOS formatted disk that does not have enough free space, a second dialog box appears that asks you to change your selection. If you see this dialog box, select *Ok* to close it and select fewer job files for the transfer or use another floppy disk with more space. If your floppy disk has enough free space, select *Ok* to close the first dialog box and you'll initiate the transfer process. During the transfer, a dialog box says: *Transfer in progress. Please wait...* and the name of each job file appears in the Status line as the system copies it to the floppy disk. After the transfer, a dialog box says: *Transfer complete*. You select *Ok* to close the dialog box, and remove the floppy disk from the floppy drive.

Floppy → hard disk, Hard disk → hard disk : The system copies job files from a floppy disk to the Opti-Probe's hard disk and from hard disk to hard disk in the same sequence as the hard disk to floppy operation, except for some hard disk-specific messages, and data entry fields for the job file path. If you have overwrite privileges and *Ask for confirmation* is entered in the *Job file overwrite* field, and the destination job file path already exists, a dialog box says: *DIR\SUB\JOB already exists. Overwrite?* You select *Ok* to overwrite the job file or *Cancel* to skip the overwrite process. If you don't have overwrite authority for the job file, a dialog box informs you of this, and you must change the destination job file path to perform a successful transfer. After the transfer is completed, if *Never overwrite* is entered in the *Job file overwrite* field and one or more destination job file paths already exist, a list of skipped (i.e., not copied) job file paths appears, as shown in Figure 3.18.

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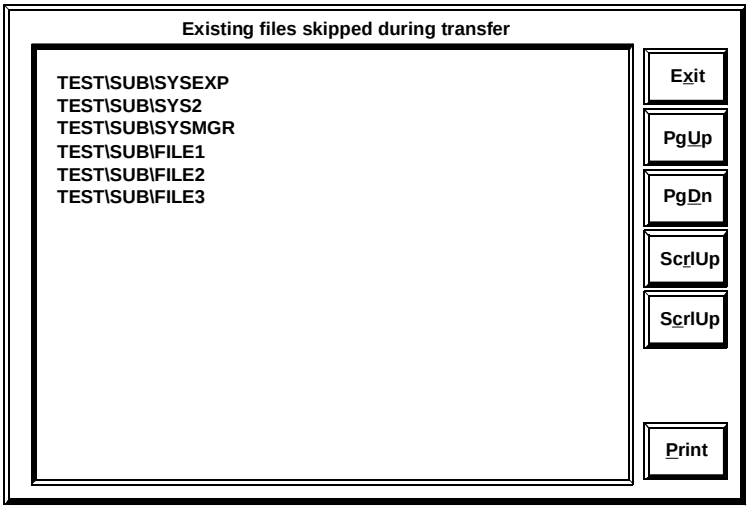
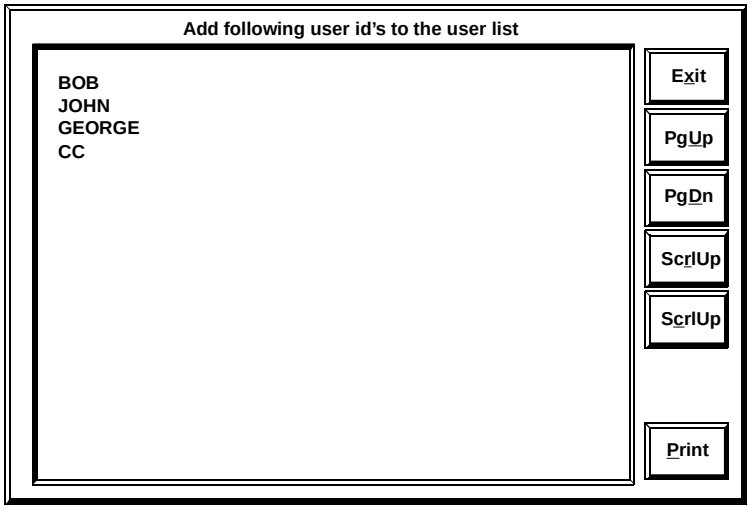
Figure 3.18 Skipped files window



After the transfer operation, if the job files copied to the Opti-Probe's hard disk included any new user id's, a list of these user id's appears, as shown in the example in Figure 3.19. If this list appears, print it by selecting the *Print* button, and give the list of new user id's to your System Manager to add to the Opti-Probe's user list.

The first time you open a job file copied from a floppy disk or hard disk, the system checks the Film library for an identical film setup. If the system does not find this film setup, a Status line message informs you that it is being added to the Film library (see Setup/Library/Film, later in this section).

Figure 3.19 Add user id window



If the lists in the two previous windows are too long to be displayed at once, four additional buttons are activated in each window's right margin. Following is a description of each of these buttons:

PgUp: Moves up in the list by 1 page (16 lines).

PgDn: Moves down in the list by 1 page.

ScrlUp: Moves up in the list by 1 line.

ScrlDn: Moves down in the list by 1 line.

3.5 DATABASE MENU

When you select *Setup*/*Database*, the Setup/Database menu appears with three options, as shown in Figure 3.20.

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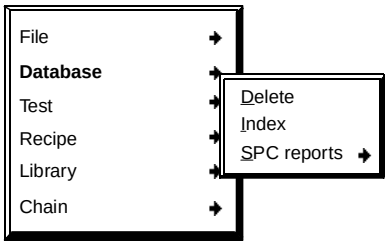
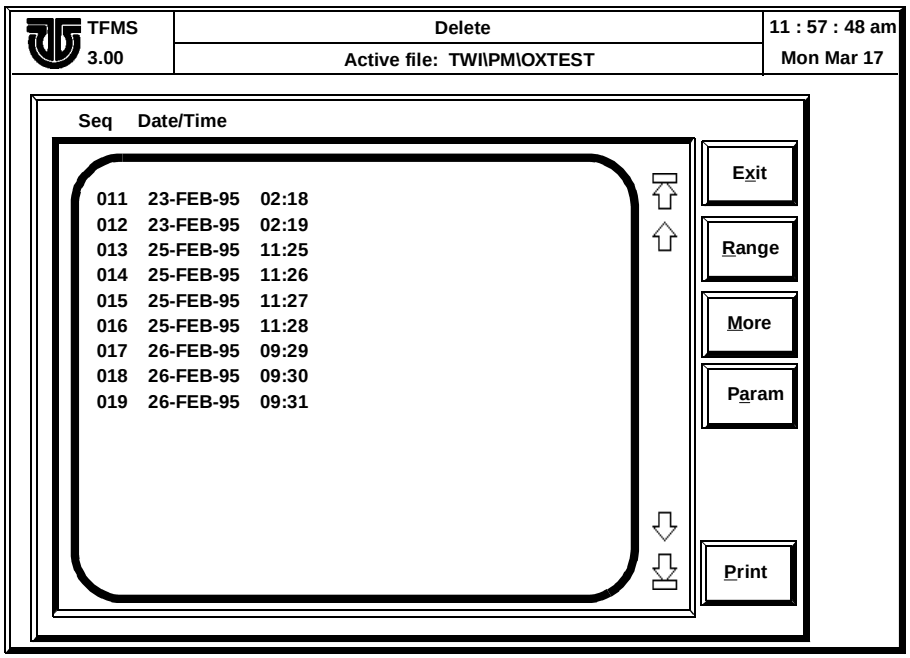
Figure 3.20 Setup/Database menu



3.5.1 Delete

When you select *Setup*/*Database*/*Delete* , the Delete window appears, as shown in Figure 3.21. If you do not have change privileges for this job file, a dialog box informs you. You can delete a specific measurement record from the database by selecting it with the light pen. A confirmation dialog box appears, which informs you that the system is about to permanently remove the record. Select *Ok* to delete the record or *Cancel* to stop the deletion operation. Once you delete a record, it is unrecoverable, and the system removes the record number from the database. If you want to re-use the deleted record numbers, re-index the database but do not change the current defaults (See "Database/Index" later in this section). After you delete a measurement record, select the *Exit* button to close the Delete window.

Figure 3.21 Delete window



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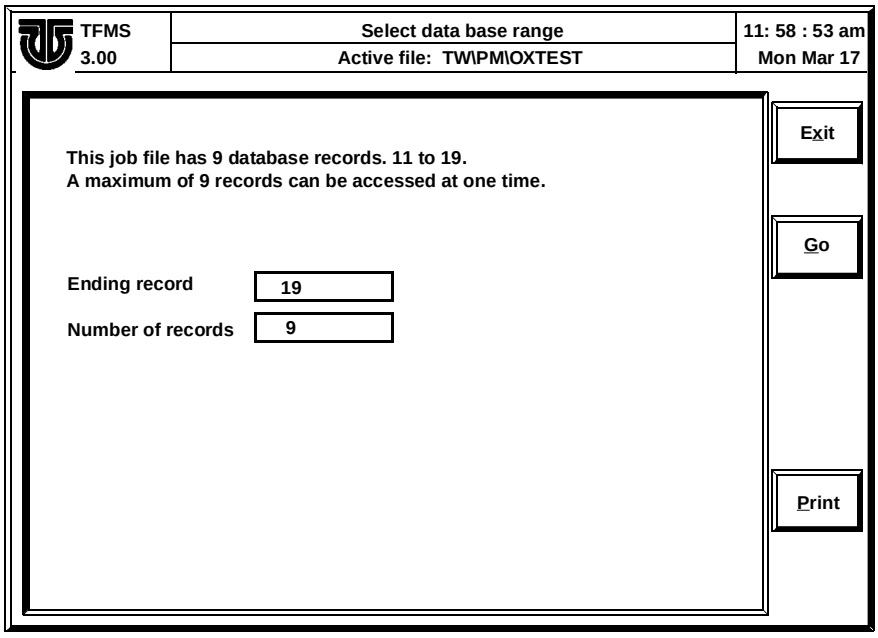
If you do not want to delete any measurement records, select the *Exit* button to close the Delete window.

Once you delete a record in the Delete window, it cannot be retrieved. Be sure you really want to delete a measurement record before using this function.

More button

When you select the *More* button in the Delete window, the Select data base range window appears, as shown in the example in Figure 3.22 (with 9 records saved in the database). You see a *Go* button in the right margin and two fields, *Ending record* and *Number of records*. You can select a range of records to display by making entries in these fields. The default number of records that the system displays is either the total number of records saved in the database, or the number entered by the System Manager in the System parameters window. For a very large database, a small default entry allows faster access to the job file and its database. You can temporarily override this default setting by entering a larger or smaller number of records in this window.

Figure 3.22 Select data base range window



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Ending record: In this field, you can enter the last record that you'd like to display.

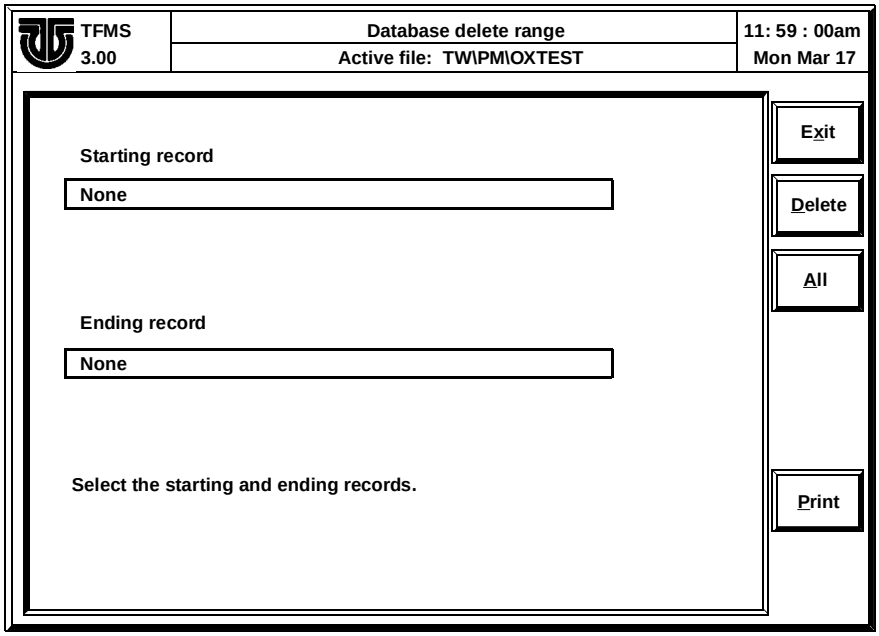
Number of records: In this field, you can enter the number of records you'd like to display.

Go button: When you select the *Go* button, the range of records you selected appears in the Delete window.

Range button

You use the *Range* button to select a range of database records to delete. When you select this button, the Database delete range window appears, as shown in Figure 3.23.

Figure 3.23 Database delete range window



Starting record: When you select this field, the Database selection window appears. For more information on database windows, see Section 2, "Operation Summary." You use the scrolling arrows to find the desired starting record and the light pen to select it. After you select the starting record, the Database delete range window reappears with the selected record displayed in the *Starting record* field.

Ending record: You select the ending record the same way you chose the starting record.

After you select the starting and ending records, the Database delete range window lists the number of records selected for deletion. The range includes all the records between the starting and ending records.

Delete button: You select this button to remove the range of records selected for deletion. A confirmation dialog box appears, which informs you that the system is about to permanently remove these records. Select *Ok* to initiate the delete operation or *Cancel* to stop it. During the delete operation, the center of the screen is blank and you see each record number displayed in the Status line as the system removes it. You also see a *Halt* button in the right margin (for halting the delete process). For a large database, the system deletes each record in 1-2 seconds, while it deletes records much faster for a small database.

All button: You select this button to delete all the records in the database. A confirmation dialog box appears, which displays the range of records that the system is about to permanently remove. Select *Ok* to delete these records or *Cancel* to stop the delete operation.

Param button

When you select the *Param* button, the Database index setup window appears, where you can specify which display fields appear in the Delete window. This feature temporarily overrides the job file's default database display setup. For complete details on configuring the Database index, see "Index" next in this section.

3.5.2 Index

When you select *Setup*/*Database*/*Index*, the Database index setup window appears, as shown in the example in Figure 3.24. In this window, you can specify how the system sorts database measurement records for a job file, and the type of information that appears in the display fields in Saved Measurement windows or Database index reports. You can specify up to 5 display fields for each record.

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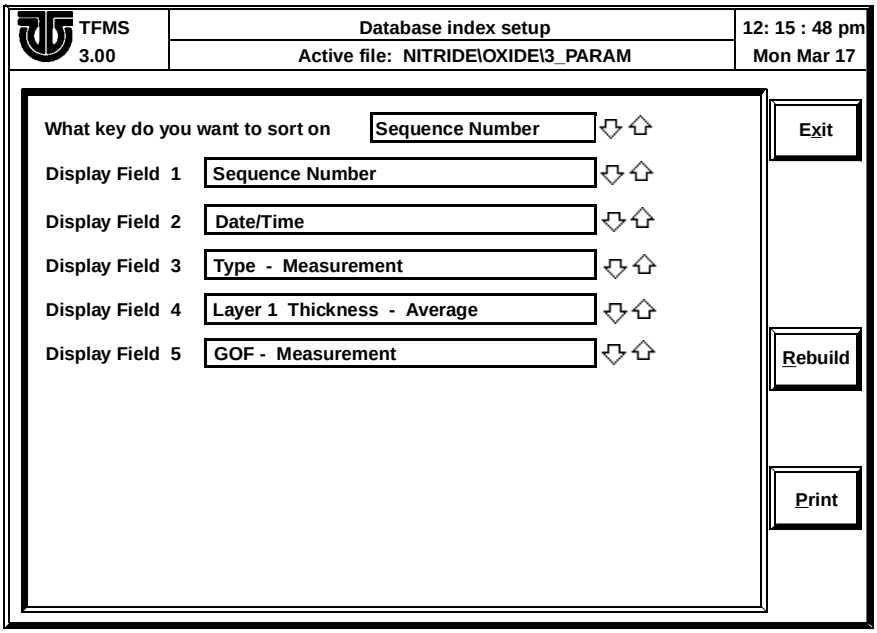
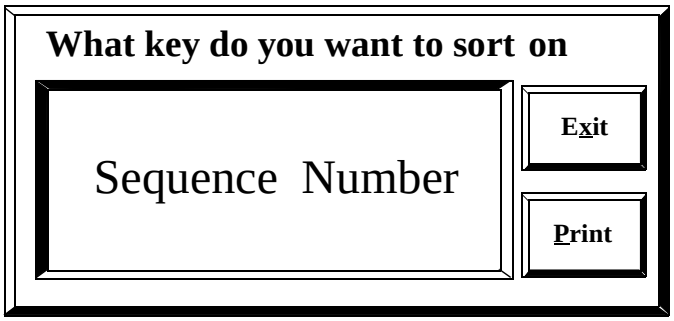
Figure 3.24 Database index setup window



What key do you want to sort on

When you select the *What key do you want to sort on* field, only one option appears, *Sequence Number*, as shown in Figure 3.25. Currently, you can only sort the database using the sequence number.

Figure 3.25 What key do you want to sort on pop-up menu

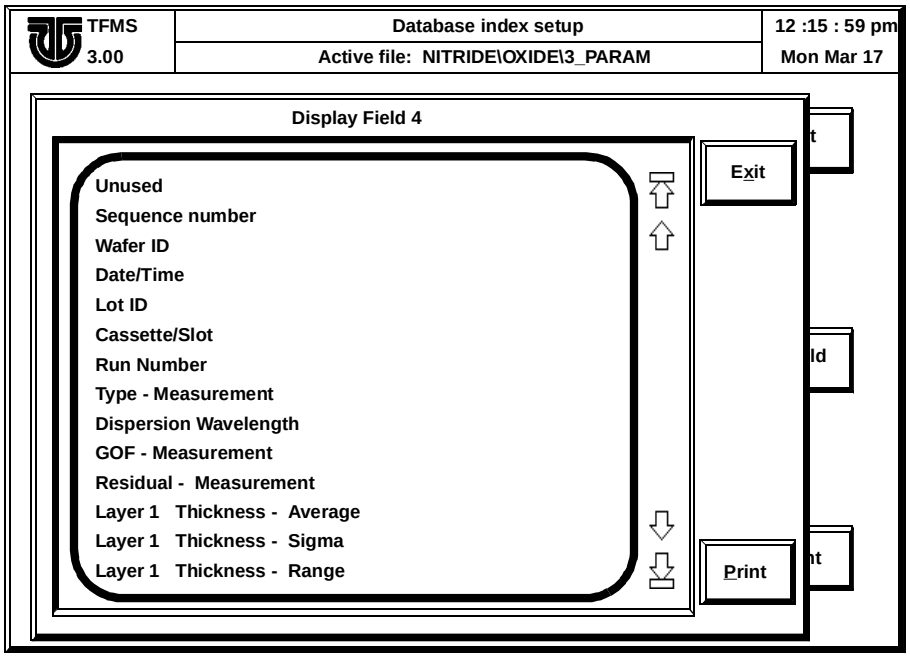


Display fields 1-5

Specify the type of information that appears for each measurement record in the job file's Saved Measurement window and Database index report. You can select a

maximum of five display fields. When you select any of the *Display Field* (1-5) fields, the Display Field window appears with a list of options, as shown in the example in Figure 3.26. You can use the scrolling arrows to view the complete list of options.

Figure 3.26 Display field 4 window



You can select from the following options:

Unused - No data displayed in field.

Sequence Number - Displays the sequence (record) number. Measurement records are numbered chronologically starting with 1

Date/time - The date and time the measurement was made.

Cassette/Slot - The cassette station and slot number of the wafer.

Lot ID - The lot identifier entered in the Process Information window at run time.

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Wafer ID - The wafer ID entered in the Cassette editor window at run time (cassette measurement only).

Run number - The run number identifier entered in the Process Information window at run time.

Type - Measurement - Abbreviated identifiers that are defined as follows: (For a description of the measurement types, see Section 3, "Engineer Functions")

SGPT = single point

LINE = line scan

AREA = area scan

TMPL = template

POLR = polar map

Dispersion Wavelength - The wavelength at which the system reports the calculated N and K values.

GOF - Measurement - Displays the average goodness of fit value for a wafer measurement

Residual - Measurement -

Layer Thickness - Average, Sigma, Range, Min/Max, Uniform

Reflect Lmag, Reflect Hmag (wavelength) Average, Sigma, Range, Min/Max, Uniform

The low magnification and high magnification laser diode or spectrometer reflectivity measurement results at the appropriate wavelength.

Reflect Sspt, Reflect Lspt (**wavelength**) - DUV systems only Average, Sigma, Range, Min/Max, Uniform

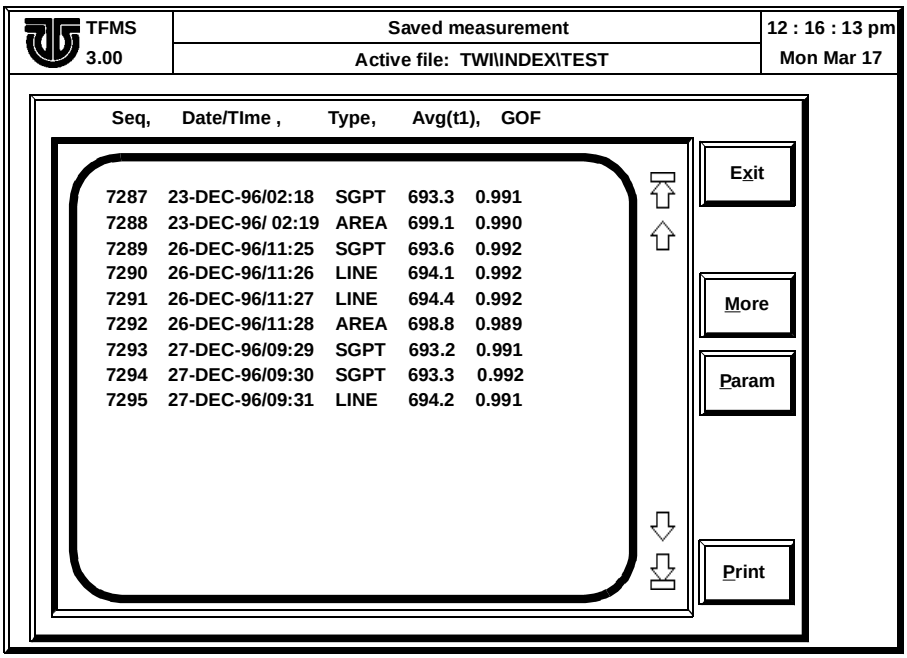
The small spot and large spot UV reflectivity measurement results at the wavelength specified by the active job file.

Rebuild

When you select the *Rebuild* button after specifying the database index setup, a dialog box appears that says: *Rebuild will reorder the sequence numbers in the database to remove gaps in the data. All database records will have the current*

correlation setup values added if a record does not have correlation data already saved. Select Ok to continue, Cancel to quit. When you select *Ok*, the system re-indexes the database. While the system performs the re-indexing process, a dialog box appears that says: *Rebuilding database Please wait....* If the database is large, this step can take several minutes; the re-indexing process runs much faster in a small database. When the re-indexing operation is complete, the dialog box closes and you return to the Database index setup window. The re-indexing process re-numbers the database records, filling in any gaps in the numbering sequence for any deleted data. Figure 3.27 shows the Save measurement window after rebuilding the database according to the entries in Figure 3.24.

Figure 3.27 Saved measurement window (after re-indexing database)



If you try to exit the Database index setup window before saving your changes (*Rebuild* button), a dialog box appears that says: *Warning: Database index display fields have been altered, but the database will not be modified until the "Rebuild" button is selected. Select OK to exit, Cancel to remain in this screen.* If you want to save your changes, select the *Cancel* button in the dialog box, and then select the *Rebuild* button.

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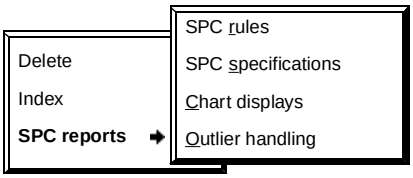
3.5.3 SPC reports

When you select *Setup/Database/SPC reports* , the SPC (statistical process control) reports menu appears with four options, as shown in Figure 3.28. When you select one of these options, the corresponding data entry window appears. In these windows, you enable and configure statistical process control.

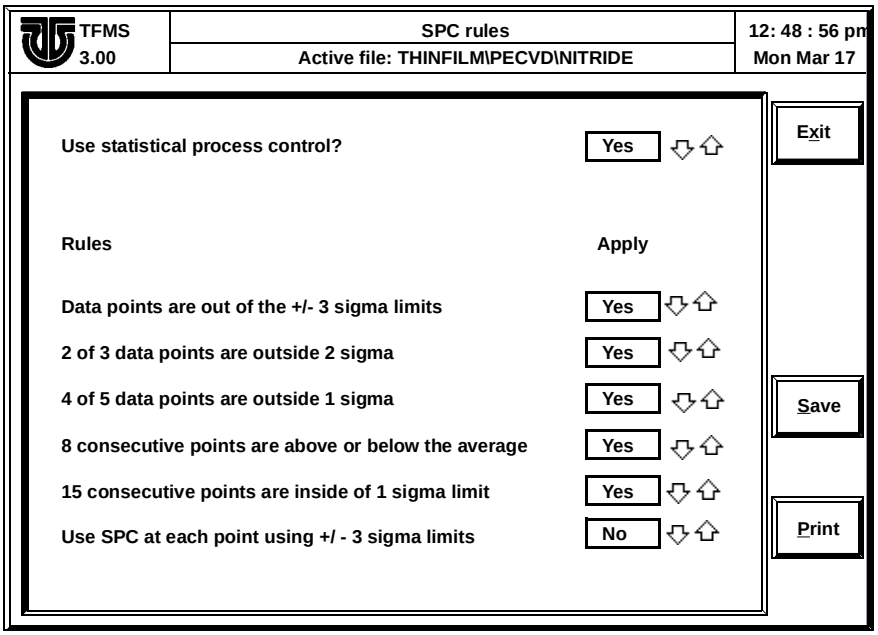
Figure 3.28 SPC reports menu



SPC Rules

When you select *SPC rules* in the SPC reports menu, the SPC rules window appears. In this window, you set up the SPC rules that are applied to your measurements. When you select *Yes* in the *Use statistical process control* field, the window looks like the example in Figure 3.29.

Figure 3.29 SPC rules window



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Use statistical process control?::This field enables or disables statistical process control. When you select *No*, you disable SPC and the Rules fields do not appear in the window. When you select *Yes*, you enable SPC, and the Rules fields appear, as shown in Figure 3.29.

Rules:Following is a description of the five Western Electric SPC rules used by the Opti-Probe. A data point designates an entry in any of the SPC charts described below. In a multi-site measurement, a data point is the selected parameter's average value for all the sites. If you select *Yes* for any of these rules, a warning message appears when that rule is violated. Target and sigma values are defined under *SPC specifications*, later in this section.

- Data points are out of the +/- 3 sigma limits
- One or more points are more than 3 sigma from the target value.
- 2 of 3 data points are outside 2 sigma
- Two out of three consecutive points are more than 2 sigma from the target value.
- 4 of 5 data points are outside 1 sigma
- Four out of five consecutive points are more than 1 sigma from the target value.
- 8 consecutive points are above or below the average
- (self-explanatory)
- 15 consecutive points are inside of 1 sigma limit
- Fifteen consecutive points are less than 1 sigma from the target value.

Use SPC at each point using +/ -3 sigma limits:Tracks SPC at each measurement point in addition to the measurement average. The only SPC rule that is applied to each point is *Data points are out of the +/ -3 sigma limits*. The other SPC rules are only applied to measurement averages.

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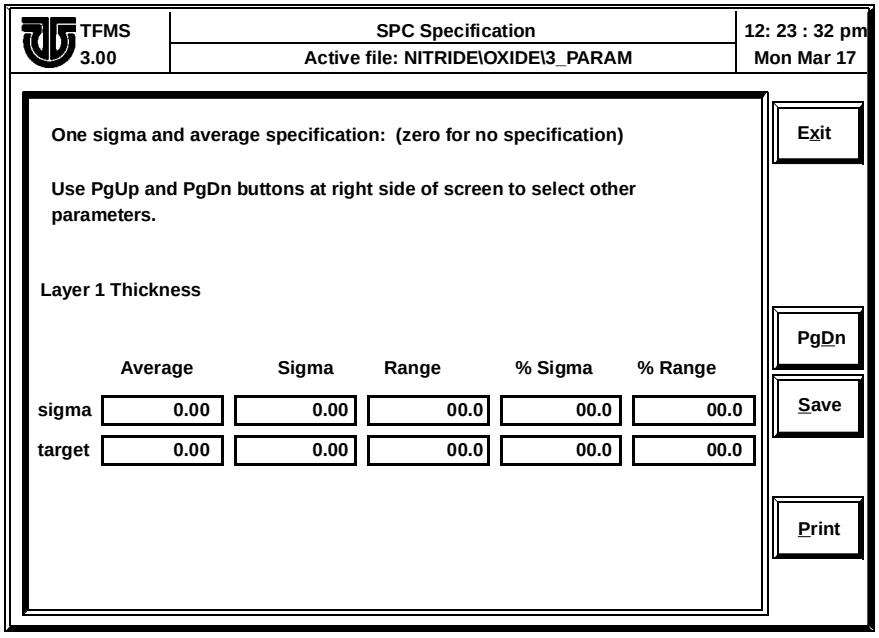
When you change any of the parameters in this window, and then select the Exit button, a dialog box appears with a reminder message that says: *To fully activate SPC, you must enter the targets and sigmas under the SPC specifications menu, and select which charts to display under the Chart display menu.*

SPC specifications

When you select *Setup*/*Database*/*SPC reports* /*SPC Specifications*, the SPC Specification window appears, as shown in the example in Figure 3.30. In this window, you can enter the target (desired) values for the average, sigma, range, % sigma, and % range for each measurement parameter (e.g., average, sigma, etc. of all the thickness readings in a 9 site polar map). If you don' t want to specify values for any of the SPC options, (e.g., *% Sigma*, and *% Range*), enter 0.00 in the corresponding fields. Similarly, you can enter the desired one sigma values for process variation in the measurement repeatability chart. The first measurement parameter appears first. If your job file is set up to measure more than one parameter, you can select the *PgUp* or *PgDn* button to display another parameter.

Figure 3.30 SPC Specification window



One sigma and average specification: (zero for no specification): You enter target and one-sigma values for the Average, % Sigma, and % Range plots for each

of the measurement parameters specified in the Film parameters window, discussed later in this section. When you enter values in these fields, you can customize the SPC plot and specify process ranges for the SPC rules. These values also determine which colors are used in a color map display. See the description of the Color parameters window, later in this section. You don't have to enter values for any chart you're not using with SPC rules.

Sigma: These fields specify process standard deviation values for the average, sigma, range, % sigma, and % range charts for each measurement parameter.

Target: These fields specify process target values for the average, sigma, range, % sigma, and % range charts for each measurement parameter.

Chart displays : When you select *Setup*/*Database*/*SPC reports* /*Chart displays*, the SPC Display Selection window appears, as shown in Figure 3.31. In this window, you specify whether or not the system displays an SPC chart(s) after each wafer measurement. The system can display one SPC chart for each parameter measured plus GOF and Residual. Each display appears on the screen for the time specified in the Output control window, described later in this section.

Each line in this window indicates one of the parameters that the system measures (plus GOF and Residual), which is specified in the Film parameters window (described later in this section). In the example in Figure 3.31, Film Thickness is the only parameter measured by the active job file. You select *Yes* or *No* in each of the *Chart type* fields to configure the SPC chart for that parameter plus GOF and Residual. If a job file is set up to measure more than one parameter, you follow this same procedure to configure the SPC chart(s) for the other parameters. You can display an SPC chart(s) after a measurement for any, all, or none of the measurement parameters.

If a job file is set up for a reflectivity measurement, the system displays the reflectivity as parameter 1 and does not include GOF or Residual.

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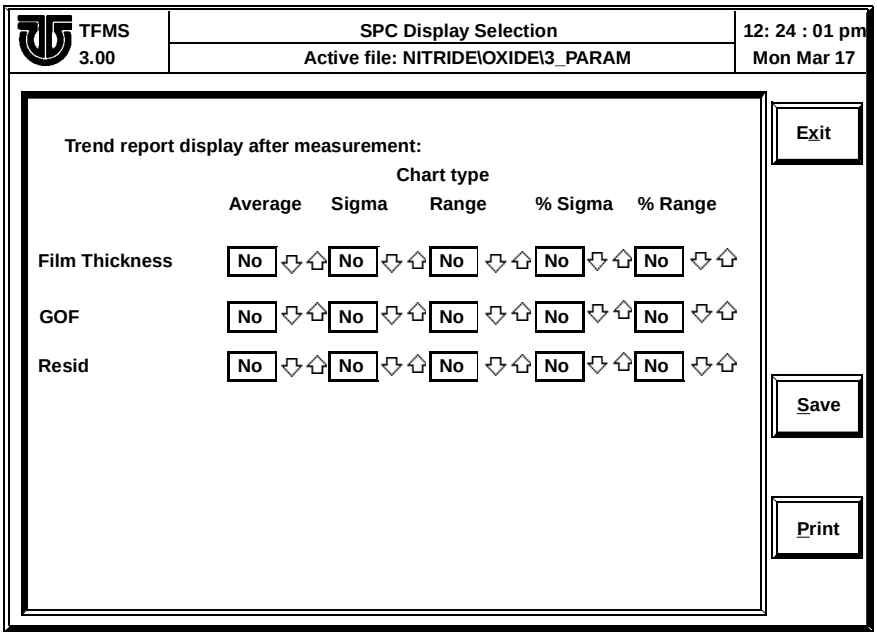
Figure 3.31 SPC Display Selection window

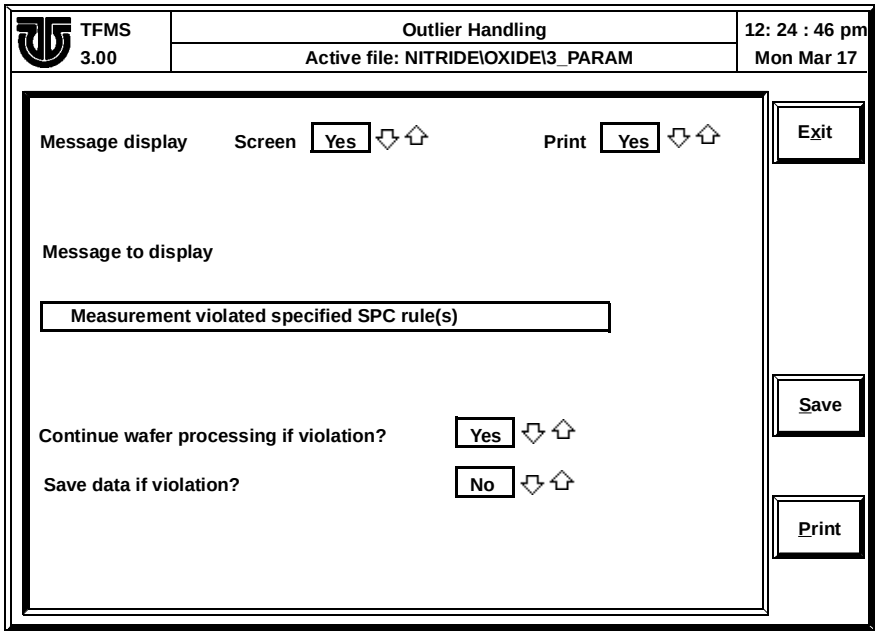


The system requires two (or more) measurements to generate an SPC plot. If you enable one of these charts before you have any saved data, a dialog box appears after the first measurement (instead of an SPC plot).

Outlier handling

When you select *Setup*/*Database*/*SPC reports* /*Outlier handling*, the Outlier Handling window appears, as shown in Figure 3.32. In this window, you specify how the system should respond when statistical process control is turned on in the SPC rules window and one or more SPC rules is violated (this situation results in an outlier). When you turn off statistical process control, the entries in this window do not function.

Figure 3.32 Outlier Handling window



Message display/Screen :Specifies whether or not a message is displayed on the screen.

Message display/Print :Specifies whether or not the system prints a message on the printer.

Message to display :Specifies any message you'd like to appear, when you enter it in this field's keyboard window. The default message says: *Measurement violated specified SPC rule(s).*

Continue wafer processing :Specifies whether wafer processing (cassette measurement) should continue or come to a stop when an outlier occurs.

Save data if violation?Specifies whether the system saves data if an SPC violation occurs (when the active job file is set up for automatic data saving).

If you disable SPC, but specify target and sigma values, chart displays with target and sigma lines still appear. Since no SPC rules are applied, no violation warning message appears.

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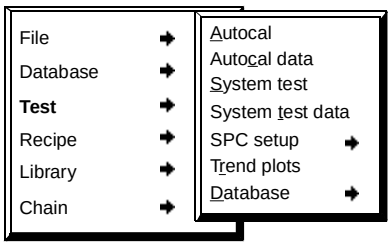
3.6 TEST MENU

When you select *Setup*/*Test*, the Test menu appears, as shown in Figure 3.33.

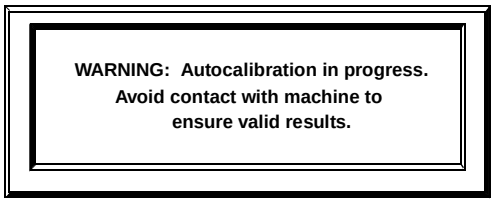
Figure 3.33 Test menu



3.6.1 Autocal

When you select *Autocal* in the Test menu, the system performs an autocalibration, and a message appears, as shown in Figure 3.34.

Figure 3.34 Autocalibration message



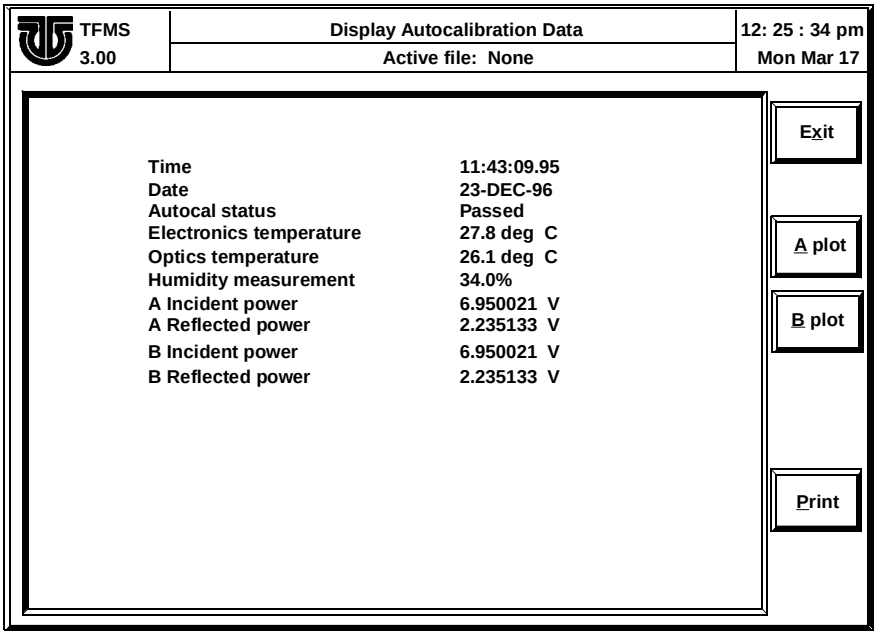
The autocalibration takes about 45 seconds, and you return to the Test menu. If the autocalibration doesn't pass, an error message appears that explains why it failed. If you see an error message, select *Ok* to close the error message box and repeat the auto- calibration once or twice. If the error message appears consistently, contact Therma-Wave for assistance.

3.6.2 Autocal data

When you select *Setup*/*Test*/*Autocal data*, the Display autocalibration Data window appears, as shown in Figures 3-35 and 3-36 for systems without an ellipsometer and systems with an ellipsometer, respectively. It displays the most

recent autocalibration information. You see *A plot* and *B plot* buttons in the window's right margin.

Figure 3.35 Display Autocalibration Data window (systems without an ellipsometer)



The following information is displayed for all Opti-Probe systems:

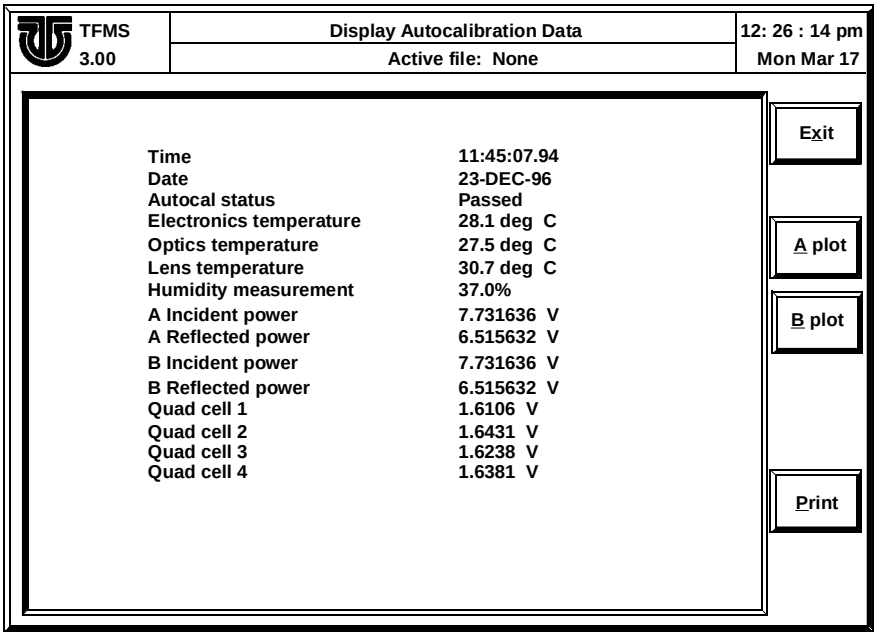
- Time and date of the most recent autocalibration
- Status (passed or failed) of the most recent autocalibration
- Temperatures in degrees centigrade for the electronics and for the optics plate
- Relative humidity in percent
- A and B incident and reflected laser power in volts

In addition to the above data, the following information is displayed on systems with an ellipsometer installed (as shown in Figure 3.36):

- Temperature in degrees centigrade for the high magnification objective lens

- Signal levels in volts for the quad-cell detector

Figure 3.36 Display Autocalibration Data window (systems with an ellipsometer)

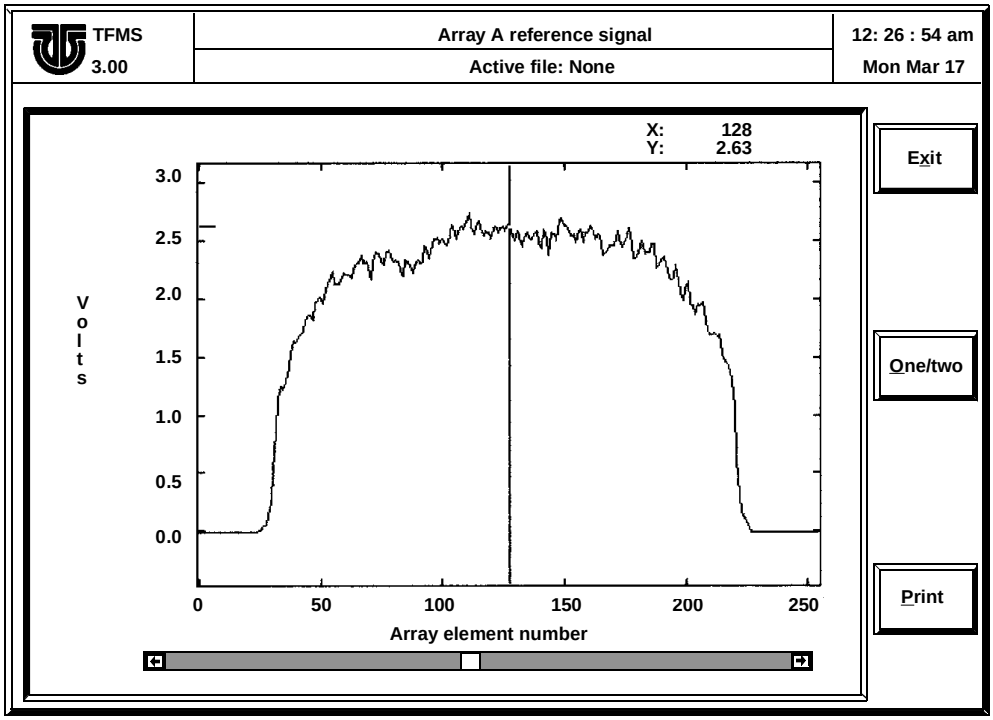


The *A plot* and *B plot* buttons are typically used for diagnostic purposes.

A plot button

When you select the *A plot* button, the Array A reference signal window appears, with a *One/two* button in the right margin, as shown in the example in Figure 3.37. The A array (s polarization) signal as measured on the internal Si reference sample is displayed in volts as a function of the array element number. For a detailed description of the *One/two* button and the scroll bar, see "Displaying a line scan measurement" in your "Getting Started" manual.

Figure 3.37 Array A reference signal window



B plot button

When you select the *B plot* button, the Array B reference signal window appears, as shown in the example in Figure 3.38. The B array (p polarization) signal appears in the same type of window as the A array signal.

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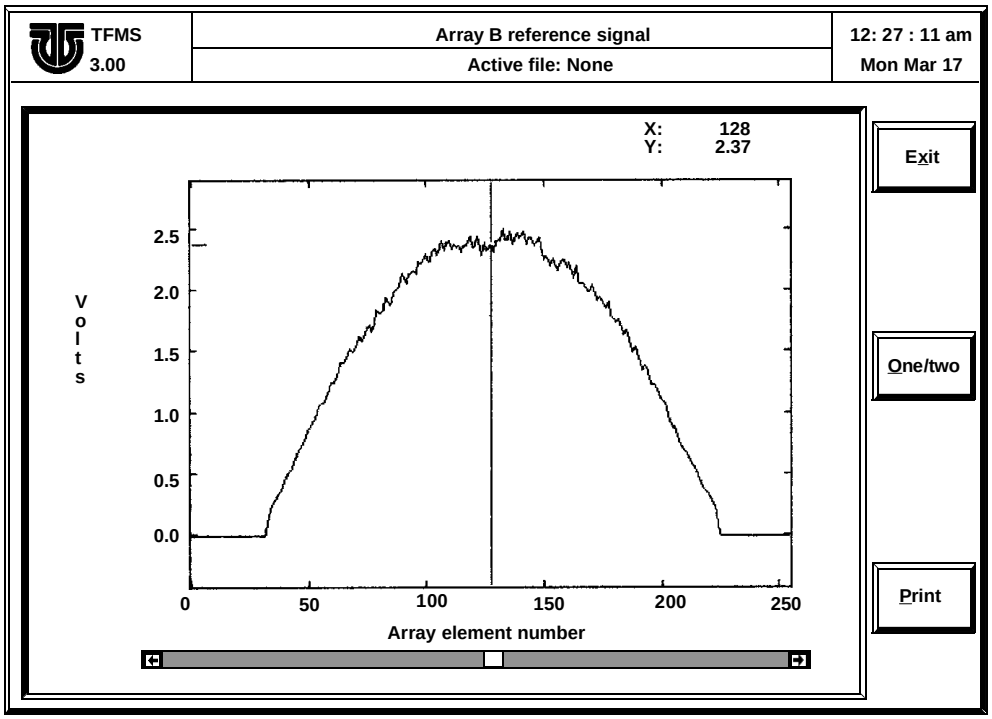
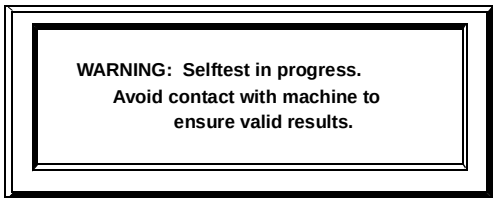
Figure 3.38 Array B reference signal window



3.6.3 System test

When you select *Setup*/*Test*/*System test*, the system performs a selftest, which includes an autocalibration and some additional tests. A message appears, as shown in Figure 3.39. The terms system test and selftest are used interchangeably in this manual.

Figure 3.39 Selftest message



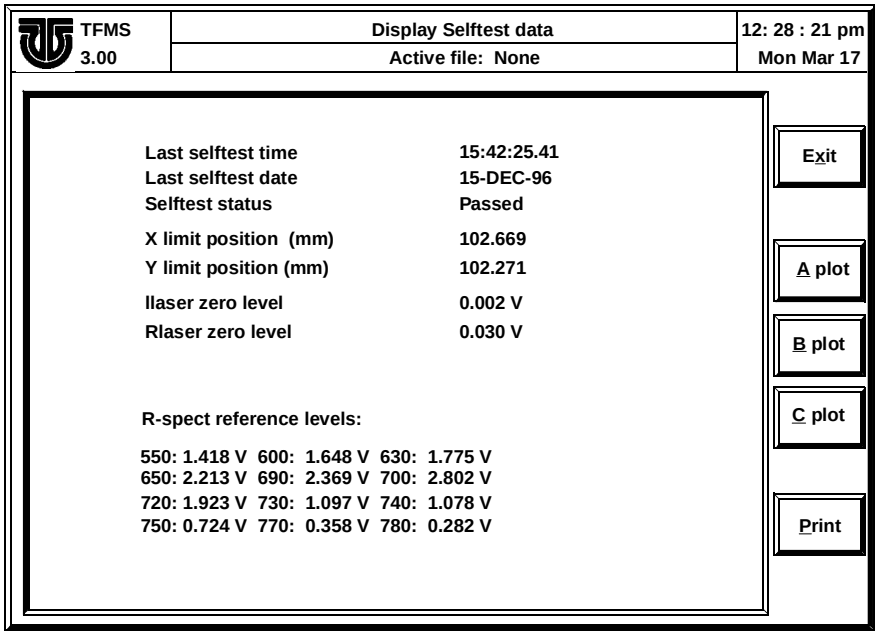
The system test takes about 3 minutes, and you return to the Test menu. If the selftest doesn't pass, an error message appears that explains why it failed. If you see an error message, select *Ok* to close the error message box and repeat the

selftest once or twice. If the error message appears consistently, contact Therma-Wave for assistance.

3.6.4 System test data

When you select *Setup*/*Test*/*System test data*, the Display selftest data window appears, as shown in Figure 3.40. It displays the most recent selftest information. You see *A plot*, *B plot*, and *C plot* buttons in the window's right margin.

Figure 3.40 Display selftest data window


TFMS
3.00
Display Selftest data
Active file: None
12: 28 : 21 pm
Mon Mar 17
Last selftest time 15:42:25.41
Last selftest date 15-DEC-96
Selftest status Passed
X limit position (mm) 102.669
Y limit position (mm) 102.271
llaser zero level 0.002 V
Rlaser zero level 0.030 V
R-spect reference levels:
550: 1.418 V 600: 1.648 V 630: 1.775 V
650: 2.213 V 690: 2.369 V 700: 2.802 V
720: 1.923 V 730: 1.097 V 740: 1.078 V
750: 0.724 V 770: 0.358 V 780: 0.282 V
Exit
A plot
B plot
C plot
Print

The following information is displayed:

- Time and date of the most recent selftest
- Status (passed or failed) of the most recent selftest
- X and Y stage limit positions, in millimeters (values are typically 102-103 mm)
- Zero levels for the incident and reflected laser signals, in volts, measured with the laser beam blocked (values are typically a few millivolts)

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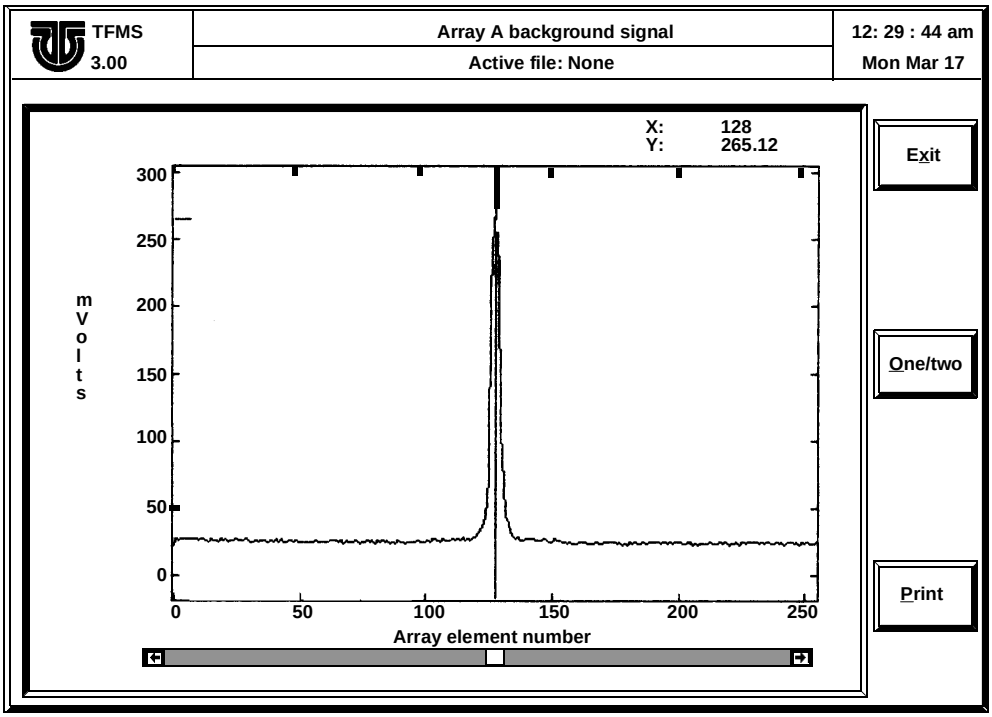
- Spectrometer signal levels, in volts

The *A plot* and *B plot* buttons are typically used for diagnostic purposes.

A plot button

When you select the *A plot* button, the Array A background signal window appears with a *One/two* button in the right margin, as shown in the example in Figure 3.41. It displays the background signal recorded on the A array. For a detailed description of the *One/two* button and the scroll bar, see "Displaying a line scan measurement" in your "Getting Started" manual.

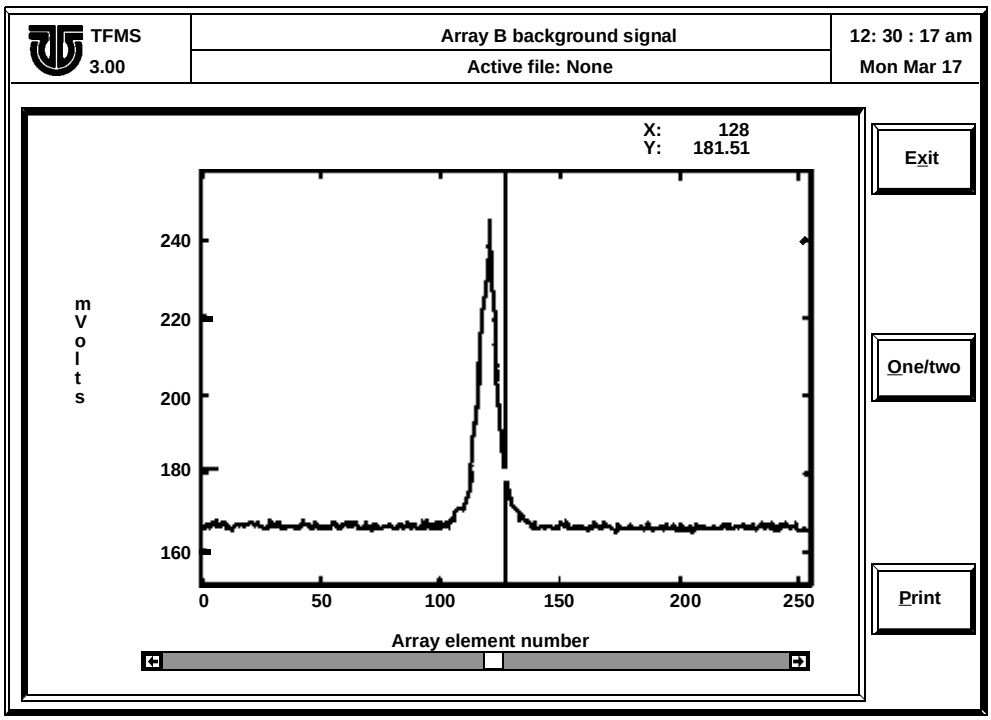
Figure 3.41 Array A background signal window



B plot button

When you select the *B plot* button, the Array B background signal window appears, as shown in the example in Figure 3.42. The B array signal is displayed in the same type of window as the A array signal.

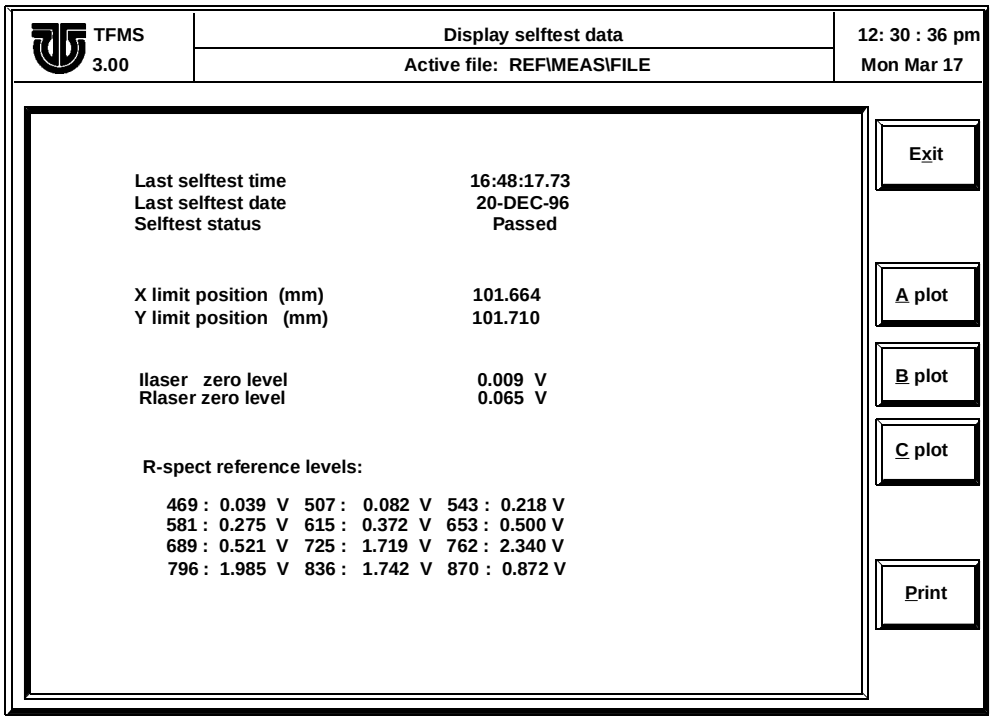
Figure 3.42 Array B background signal window



C plot button

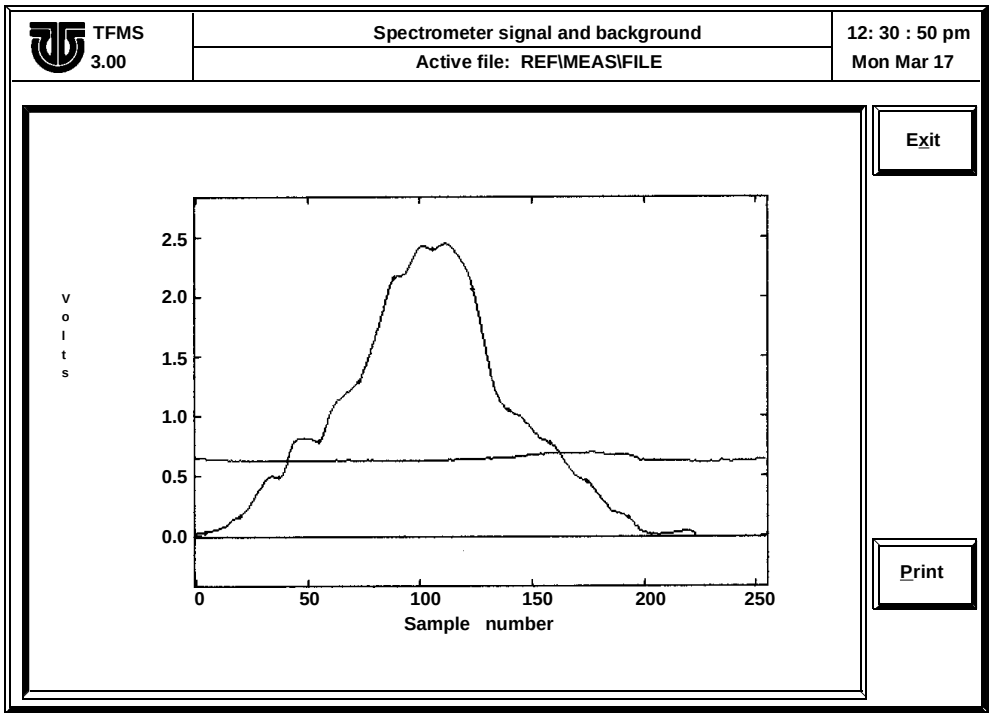
Most Opti-Probe systems have an array spectrometer installed. The Display selftest data window's *C plot* button, shown in the example in Figure 3.43, displays the array spectrometer's corrected signal.

Figure 3.43 Display selftest data window


TFMS
3.00
Display selftest data
Active file: REF\MEAS\FILE
12: 30 : 36 pm
Mon Mar 17
Last selftest time 16:48:17.73
Last selftest date 20-DEC-96
Selftest status Passed
X limit position (mm) 101.664
Y limit position (mm) 101.710
Ilaser zero level 0.009 V
Rlaser zero level 0.065 V
R-spect reference levels:
469 : 0.039 V 507 : 0.082 V 543 : 0.218 V
581 : 0.275 V 615 : 0.372 V 653 : 0.500 V
689 : 0.521 V 725 : 1.719 V 762 : 2.340 V
796 : 1.985 V 836 : 1.742 V 870 : 0.872 V
Exit
A plot
B plot
C plot
Print

When you select the *C plot* button in the Display selftest data window, the Spectrometer signal and background window appears, as shown in the example in Figure 3.44. The horizontal axis represents the spectrometer array pixel numbers. The system subtracts the background signal (0.8 - 1.2 volts) from the measured signal to provide the corrected spectrometer signal (0.0 - 2.4 volts).

Figure 3.44 Spectrometer signal and background window



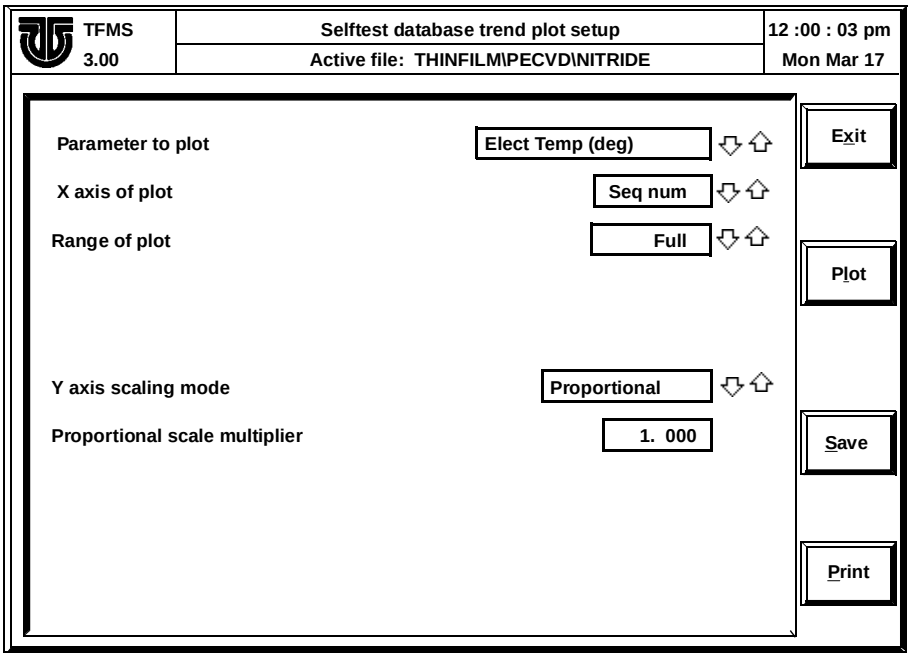
3.6.5 SPC setup

Setup/*Test*/*SPC setup* is a System Manager level function that is described in Section 7, “System Manager Functions."

3.6.6 Trend plots

When you select *Setup*/*Test*/*Trend plots*, the Selftest database trend plot setup window appears, as shown in Figure 3.45. In this window, you can set up and display a selftest trend plot. Depending on your setup entries, this window displays different parameters, as described next. This example shows the system’s default settings.

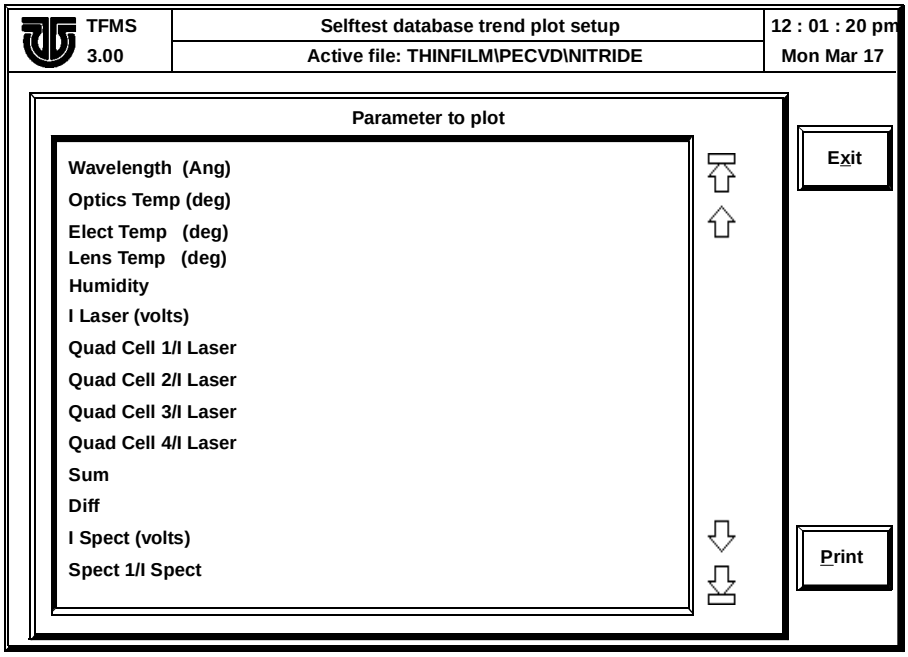
Figure 3.45 Selftest database trend plot setup window (default settings)



Parameter to plot

When you select this field, the Parameter to plot window appears, as shown in Figure 3.46. In this window, you select a parameter measured during a selftest to display in your trend plot. You can view the entire list of parameters, by using the scrolling arrows. If there aren't enough points to create a plot, a message informs you. After you select a parameter, it appears in the *Parameter to plot* field.

Figure 3.46 Parameter to plot window



X axis of plot

If you select *Seq num*, the parameters remain the same as the example in Figure 3.45. If you select *Date/Time*, two more parameters appear at the bottom of the screen, *X axis tick marks* and *X axis headings*.

X axis tick marks: You can select either *Minutes*, *Hours*, *Days*, *Weeks*, or *Months*.

X axis headings: You can select either *Hours*, *Days*, *Weeks*, or *Months*.

Range of plot

If you select *Full*, the parameters remain the same as the example in Figure 3.45. If you select *Partial* with *Seq number* selected for the *X axis plot*, two more parameters appear below the range of plot, *Starting sequence number* and *Ending sequence number*. If you then change the *X axis plot* to *Date/Time*, these parameters change to *Starting selection* and *Ending selection*.

Starting/Ending sequence number or Starting/Ending selection: If you select any of these fields, the Selftest database window appears with a list of selftests, as

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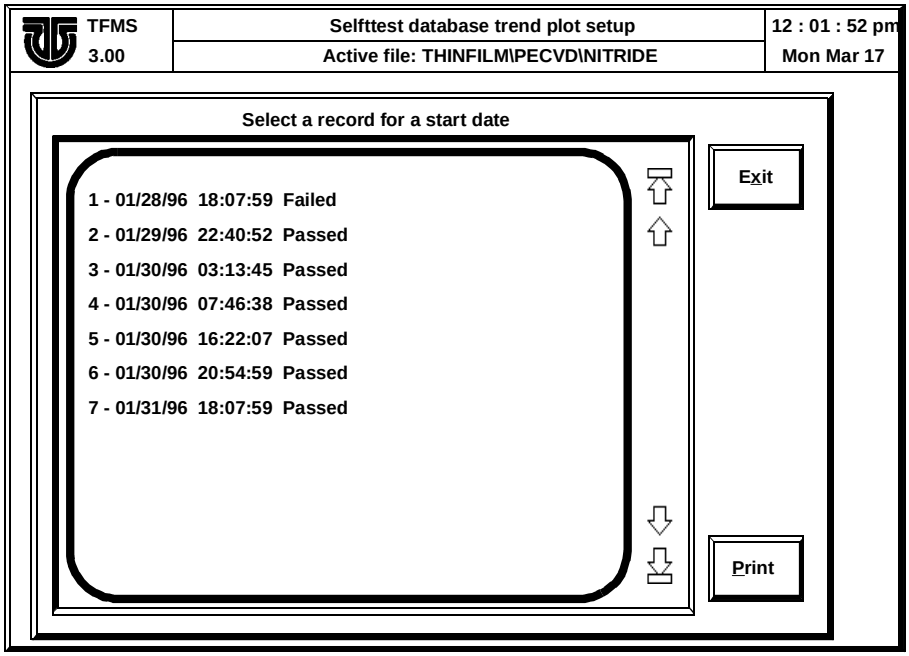
shown in the example in Figure 3.47 for *Date/Time Starting selection*. In this window, you select the starting/ending dates or starting/ending sequence numbers.

Figure 3.47 Selftest database window



Y axis scaling mode

If you select *Proportional*, the parameters remain the same as the example in Figure 45. If you select *Manual limits*, two more parameters appear below the Y axis scaling mode, *Y axis minimum value* and *Y axis maximum value*. If you select *Manual scale*, these parameters are replaced by *Manual scale factor*. You enter the desired value in each of these fields. These are the same parameters that you use for the line scan display control. For more information on these parameters, see *Setup/Recipe/Data output/Display control*, later in this section.

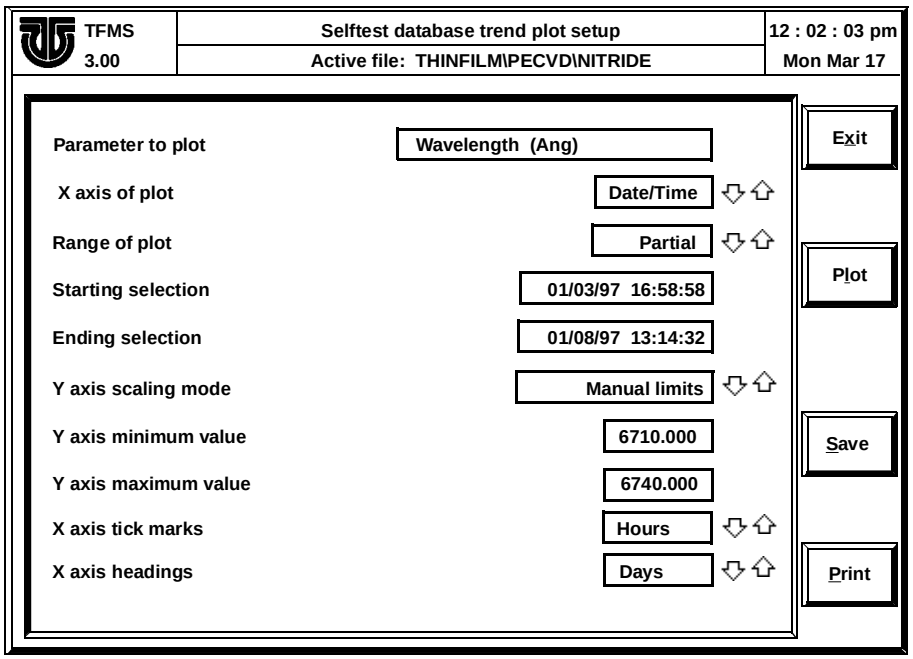
For manual limits, you may have to change the y axis minimum and/or maximum values, so they fall within the required range for the parameter you want to plot. When you change from one parameter to another, always re-check and adjust the manual limits, as required. If these values are incorrect, a message informs you of this.

Proportional scale multiplier

Determines the size of the display for the proportional display mode. This is the same parameter that you use for the line scan display control. For more information on this parameter, see *Setup/Recipe/Data output/Display control*, later in this section.

Figure 3.48 shows an example of a wavelength trend plot setup.

Figure 3.48 Selftest database trend plot setup window

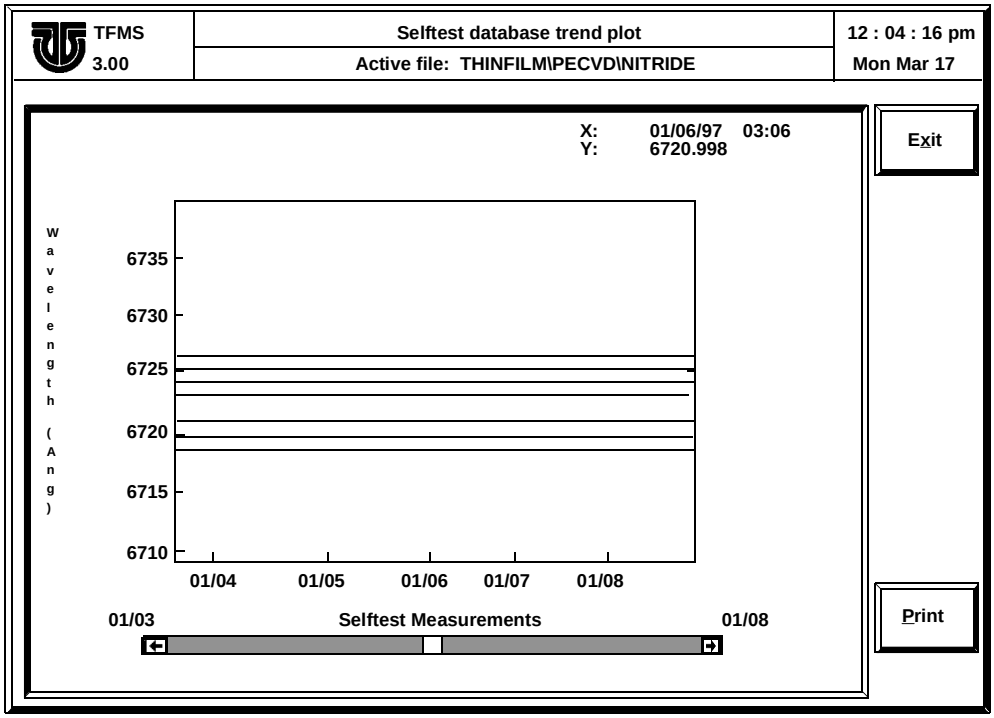


(Parameter to plot = Wavelength, X axis of plot = Date/Time)
(Range of plot = Partial, Y axis scaling mode = Manual limits)

Plot button

When you select the *Plot* button after setting up a trend plot, your plot appears in the center of the window, as shown in the example in Figure 3.49. This example reflects the trend plot setup in Figure 3.48.

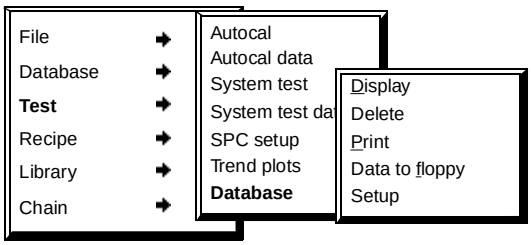
Figure 3.49 Wavelength selftest trend plot



3.6.7 Database

When you select *Setup*/*Test*/*Database*, the Database menu appears with five options, as shown in Figure 3.50. The *Delete* and *Setup* options are only accessible at the System Manager level. For a description of these options, see Section 7 "System Manager Functions."

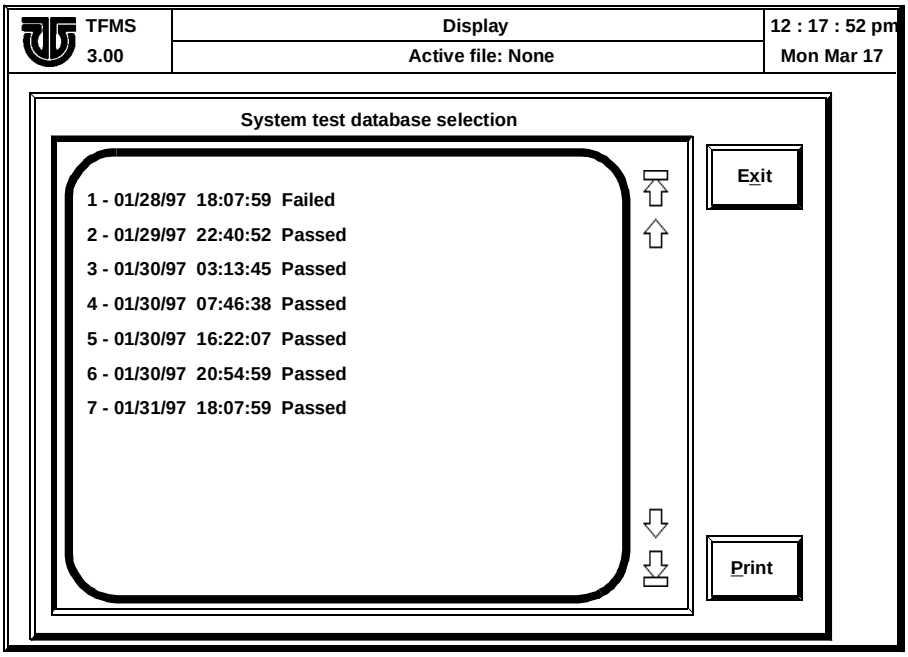
Figure 3.50 Setup/Test/Database menu



Display

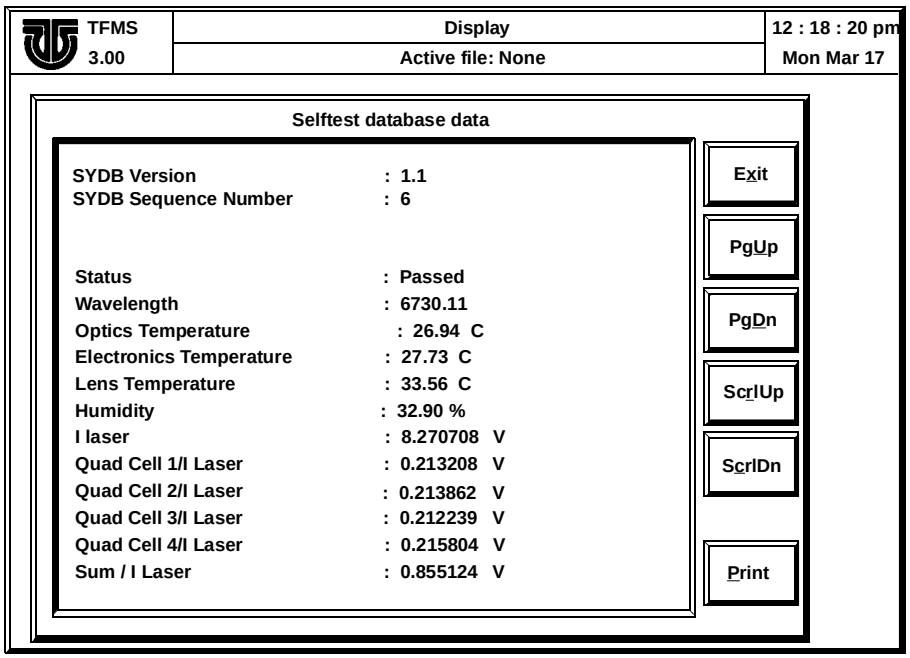
When you select *Display* in the *Setup*/*Test*/*Database* menu, the System test database selection window appears, displaying a selftest history, as shown in the example in Figure 3.51. Each selftest appears in chronological order with an indication of whether it passed or failed. If you select one of these selftest records, the corresponding data appears, as shown in the example in Figure 3.52.

Figure 3.51 System test database selection window



Display: To view all the data, use the PgUp/PgDn and ScrlUp/ScrlDn buttons.

Figure 3.52 Selftest data window



Delete

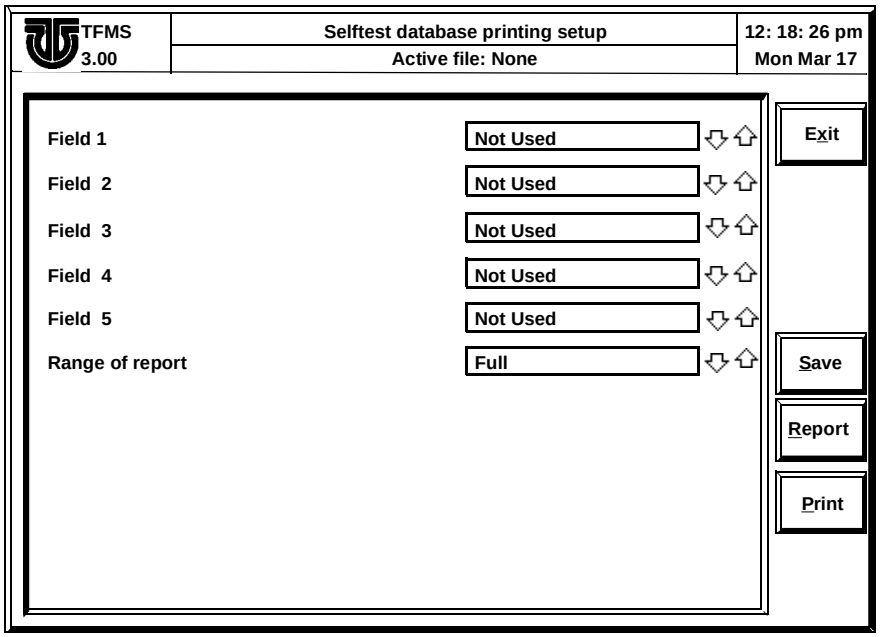
Setup/*Test*/*Database*/*Delete* is only accessible at the System Manager level and is described in Section 7.

Print

When you select *Setup*/*Test*/*Database*/*Print*, the Selftest database printing setup window appears, where you can set up the appearance of the Selftest data report, as shown in Figure 3.53. In this window, you can select the data to be printed and the order in which it appears.

Fields 1, 2, 3, 4, 5: When you select any of these fields, the categories of selftest data appear. This display looks similar to the example in Figure 3.46. When you select a category of data for each of these numbered fields, the data appears in that numerical order when you print the report.

Figure 3.53 Selftest database printing setup



Range of report: When you select this field, you can select from two options, *Partial* or *Full*. When you select *Full*, you set up the system to print all the selftest database records and the window looks like Figure 3.45. When you select *Partial*, two more fields appear: *Starting selection* and *Ending selection*. When you select either of these fields, the corresponding Selftest database window appears. This window looks like the example shown in Figure 3.47.
In this window you select a range of selftest database records to print.

Report button: When you select this button, the system prints the Selftest database report according to your printing setup.

Data to floppy

Setup/*Test*/*Database*/*Data to floppy* allows you to copy the System test database (selftest results records) to a floppy disk. This is helpful if you are having measurement problems and you want to send your system's selftest records to TWI for diagnosis. When you select this option, a dialog box asks you to insert a floppy disk. If you follow the directions in the dialog box, the system copies the System test database to your floppy disk.

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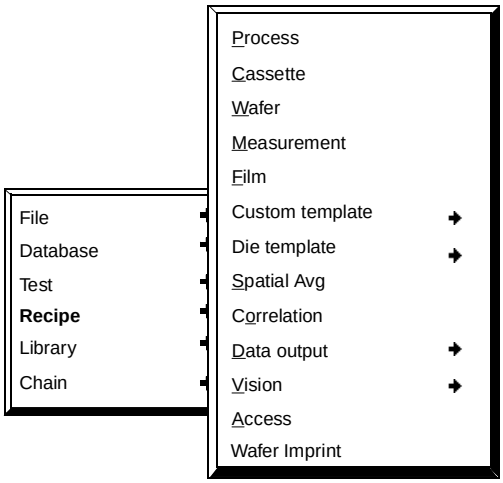
Setup

Setup/*Test*/*Database*/*Setup* is only accessible at the System Manager level and is described in Section 7.

3.7 RECIPE MENU

When you select *Setup*/*Recipe*, the Recipe menu appears, as shown in Figure 3.54. Each option in the Recipe menu represents a category of parameters that define a job file's "recipe" or configuration. To access the *Die template* and *Vision* options, your system must have a vision processor [VP]. The *Die template* and *Custom template* options are only selectable when a job file is set up for the respective measurement type. The *Wafer Imprint* option is only selectable on Wafer Imprint Reader (WIR) equipped systems.

Figure 3.54 Recipe menu (Engineer level)



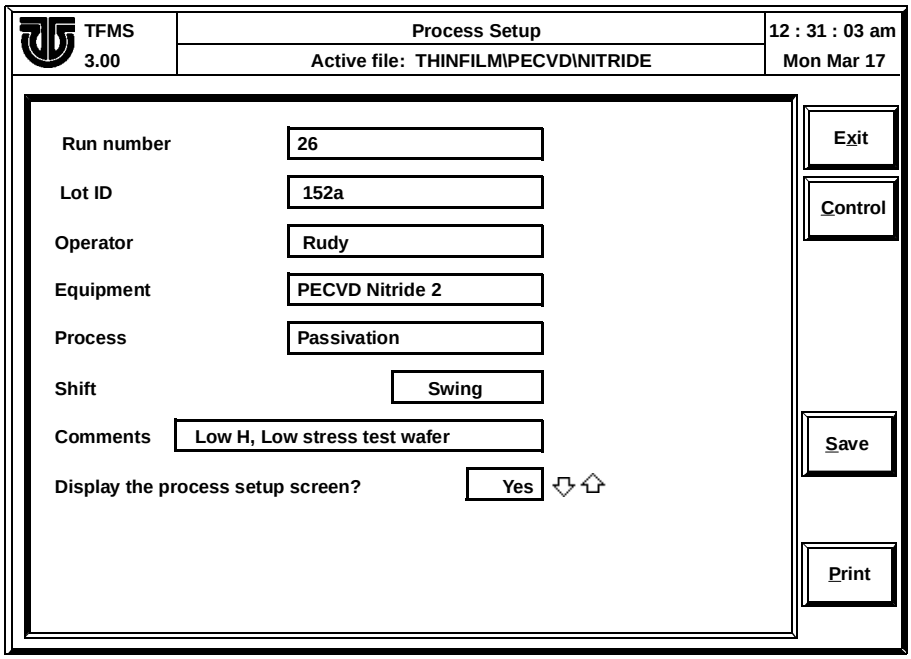
3.7.1 Save buttons

Most of the Recipe data entry windows have *Save* buttons in their right margins that allow you to save setup changes in each of these windows. When you select a *Save* button, any changes you've made in the current window are saved in the active job file.

3.7.2 Process

When you select *Setup*/*Recipe*/*Process*, the Process Setup window appears. The entries you make in this window appear in database display windows and/or Wafer measurement and Cassette summary reports (described later in this section). You can enter any information you like and skip the unnecessary fields, according to the procedures used at your facility. When you select *Yes* in the *Display process setup screen* field, a *Control* button appears in the right margin, as shown in the example in Figure 3.55. If you select *No*, this button does not appear.

Figure 3.55 Process Setup window (Display process setup screen = Yes)



When you select a Process setup field with the light pen, a keyboard window appears on the screen, as shown in Figure 3.56. You enter information in a field by typing on the keyboard with the light pen, and then selecting the *Enter* button in the keyboard window's right margin.

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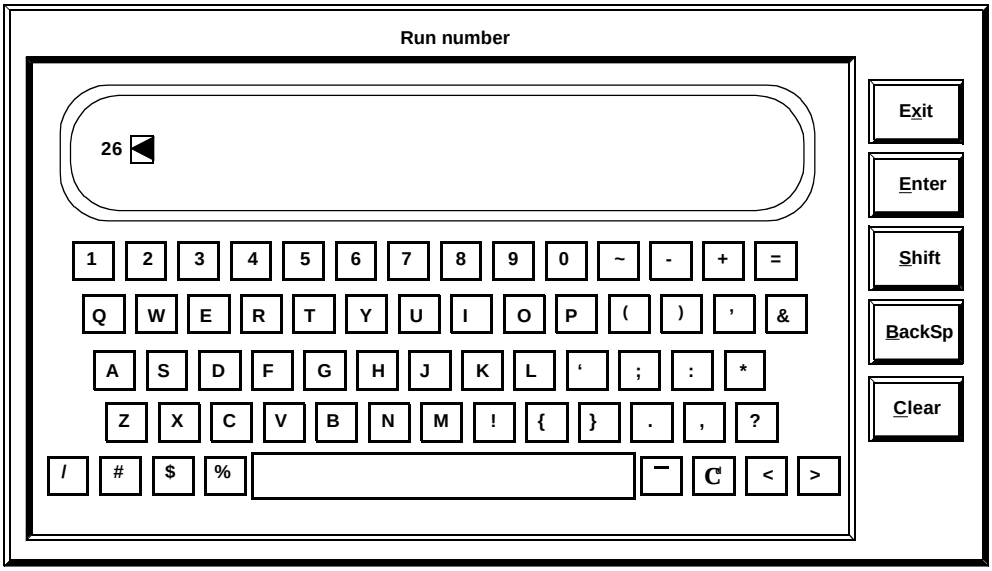
Figure 3.56 Process setup keyboard



Run number, Lot ID

You can use either or both of these fields to identify a wafer or a group of wafers. These are display fields for the Database index setup window, described earlier in this section, and also the Wafer measurement and Cassette summary report headers, described later in this section.

Operator

You can enter the name of the operator performing the measurement in this field.

Equipment

You can enter the type of process equipment that produced the film to be measured.

Process

You can enter the processing step in this field.

Shift

In this field, you can designate the shift (e.g., day, night, swing, etc.) when the measurement is performed.

Comments

You can type any measurement related comments in this field.

Display the process setup screen?

You can specify whether or not the Process Information window appears at run time. This is a toggle field, with *Yes* and *No* options. If you select *Yes*, the user can change the wafer slot selection and other parameters before the measurement. When you select *Yes*, a *Control* button appears in the Process setup window's right margin, as shown in the example in Figure 3.55.

Control button

When you select this button, the Cassette Process Setup Control window appears, as shown in Figure 3.57. This window looks similar to the Process Setup window, except for a *Back* button, which replaces the *Exit* button, the *Optional-Cassette* entries in each field, and the exclusion of the *Display the process setup screen?* field.

In this window, you can specify which fields are locked, optional, or required (must enter) when the Process Information window appears at run time. In the Process information window, you can enter process related data and change some of the existing process information entries before a cassette run. "Locked" fields are view-only and cannot be changed. "Must Enter" fields require an entry at run time. When the Process Information window appears, the system displays the status within each of these type fields."Optional" fields are selectable with no status displayed. These fields provide the operator with the option of entering or modifying information. For a complete description of this window, see your "Getting Started" manual.

When you select any of the fields in the Cassette Process Setup Control window, five options appear: *Locked*, *Optional-Wafer*, *Optional-Cassette*, *Required-Wafer*, and *Required-Cassette*. The default is *Optional -Cassette*, as shown in Figure 3-57.

Locked: Specifies that your Process Setup entry appears in the corresponding field at run time and cannot be changed.

Optional-wafer: Specifies that the Process Information window appears before the system loads a wafer, and the user has the option to make an entry in the corresponding field.

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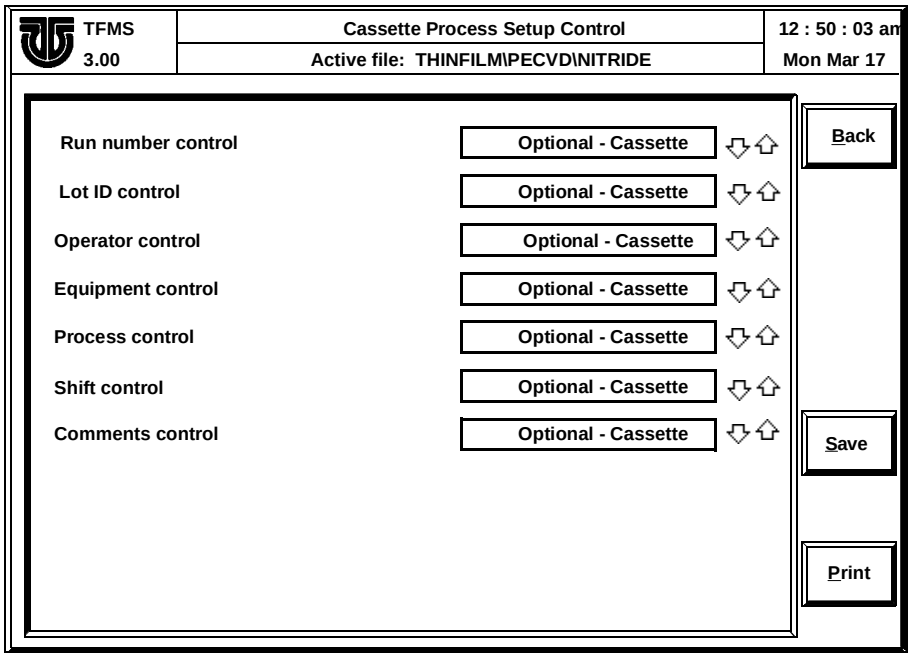
Figure 3.57 Cassette Process Setup Control window



Optional-cassette:Specifies that the Process Information window appears before a cassette measurement begins, and the user has the option to make an entry in the corresponding field.

Required-wafer:Specifies that the Process Information window appears before the system loads a wafer, and the user must make an entry in the corresponding field. If the user proceeds without making any entry, a reminder message appears.

Required-cassette:Specifies that the Process Information window appears before a cassette measurement begins, and the user must make an entry in the corresponding field. If the user proceeds without making any entry, a reminder message appears.

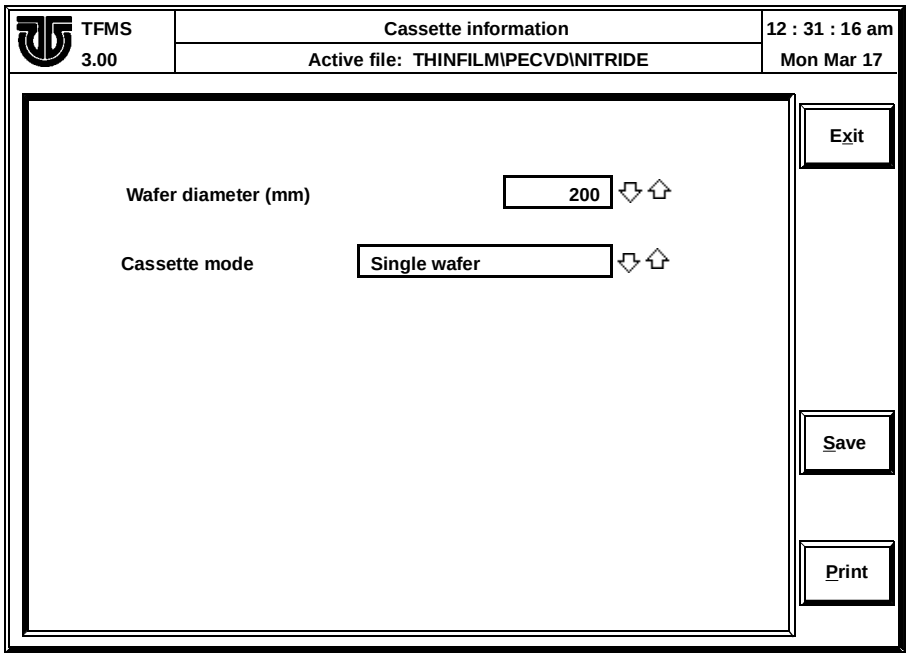
Back button:Closes the Cassette Process Setup Control window and displays the Process Setup window

3.7.3 Cassette

When you select *Setup*/*Recipe*/*Cassette*, the Cassette information window appears. In this window, you enter the cassette setup parameters. When you select *Single*

wafer in the *Cassette mode* field, the window looks like the example in Figure 3.58. When you select *Cassette* in the *Cassette mode* field, the window looks like the example in Figure 3.59. When you select this option on SMIF Indexer equipped systems, you can set up some additional parameters, as shown in Figure 3.64.

Figure 3.58 Cassette information window (single wafer mode)



Wafer diameter (mm)

In this field, you designate a wafer size. When you select this field, a pop-up menu appears with four options, as shown in Figure 3.60. You select an option from this list. Alternatively, you can toggle through the possible diameters by selecting the up or down arrow located on the right side of the field. You stop toggling when the correct size appears in the field. **Always** select a wafer diameter that is the same

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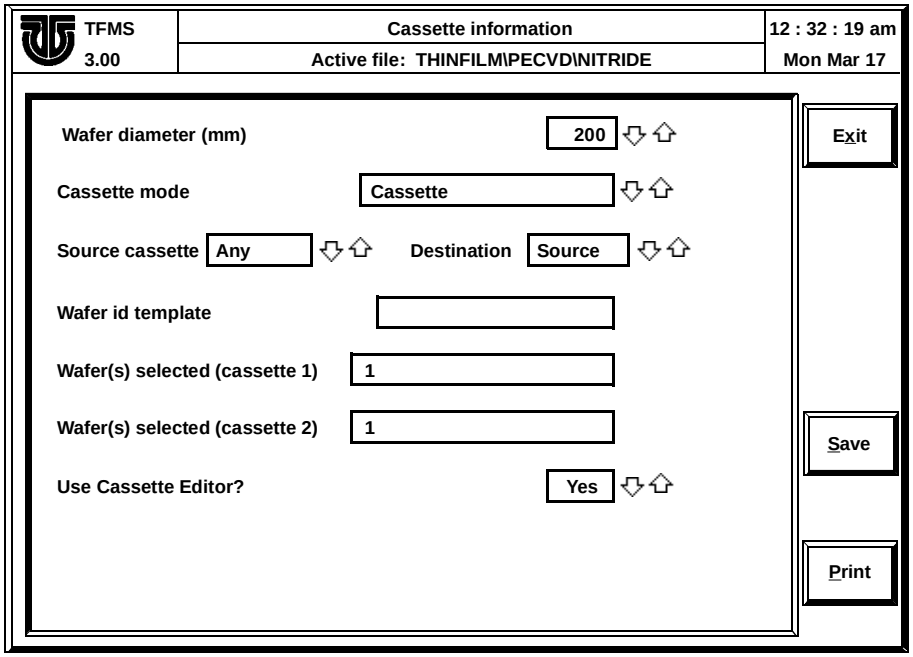
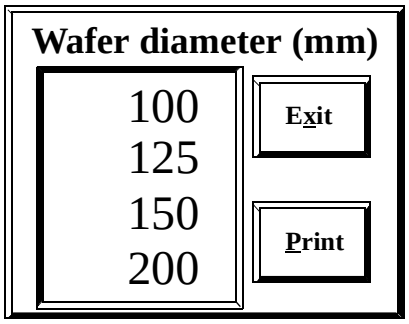
Figure 3.59 Cassette information window (cassette mode)



size as the wafer(s) you want to measure. The Opti-Probe only loads wafers from a cassette that has the same wafer diameter that you specify in this field.

Figure 3.60 Wafer diameter pop-up menu

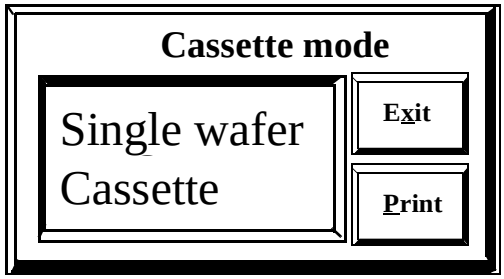


When your system is installed, Therma-Wave configures SETUP\GENERIC\JOBFILE to correspond to the standard wafer size and type for your facility. Unless you're measuring a non-standard wafer, this field should default to the correct selection.

Cassette mode

In this field, you specify whether you want wafers measured one at a time or in groups, in a specific order. When you select this field, a pop-up menu appears with two options, as shown in Figure 3.61.

Figure 3.61 Cassette mode pop-up menu



If you select *Single wafer*, the Cassette information window looks like the example in Figure 3.58. At run time, a dialog box asks the operator to enter the station and slot number for each wafer.

If you select *Cassette*, the Cassette information window looks like the example in Figure 3.59. The *Wafer(s) selected* fields appear for Cassette 1 and Cassette 2. These are the same fields that appear in the Process Information window at run time. Wafers load and unload automatically in this mode. For unattended measurements, you must disable or timeout the results display. You can also obtain a Cassette summary report when you run a cassette measurement. Both of these procedures are described under "Output control," later in this section. For additional information on cassette measurements, refer to "Setting up an automated cassette measurement" in your "Getting Started" manual.

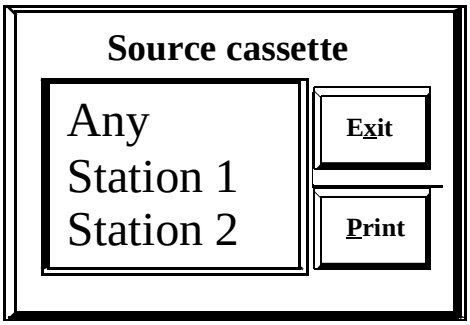
The following fields appear when you select *Cassette* in the *Cassette mode* field:

If you select the *Cassette* option, you **must** enter a wafer measurement sequence (by slot number) in the *Wafer(s) selected* field(s) [described later in this section] before the system attempts to load the first wafer for a measurement. At run time, after selecting *Measure* in the Main menu, the operator can enter or change the wafer measurement sequence in either the Process Information window or the Cassette editor window.

Source cassette: In this field, you designate the cassette station(s) used to load wafers for an automated (cassette mode) measurement. When you select this field,

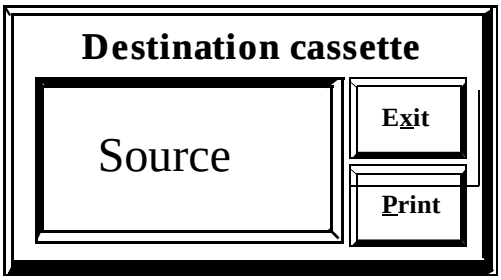
a pop-up menu appears with three options, as shown in Figure 3.62. When you select *Any*, the Opti-Probe loads wafers from either station or both stations. When you select a specific station, the Opti-Probe only loads wafers from that station.

Figure 3.62 Source cassette pop-up menu



Destination: This field designates the cassette station where wafers return after a cassette measurement. When you select this field, a pop-up menu appears with only one option, as shown in Figure 3.63. After performing a measurement, the system always returns wafers to their point of origin, except on SMIF Indexer equipped systems. If your system has a SMIF Indexer, you can specify different source and destination cassettes and configure several other parameters, as described next.

Figure 3.63 Destination cassette pop-up menu

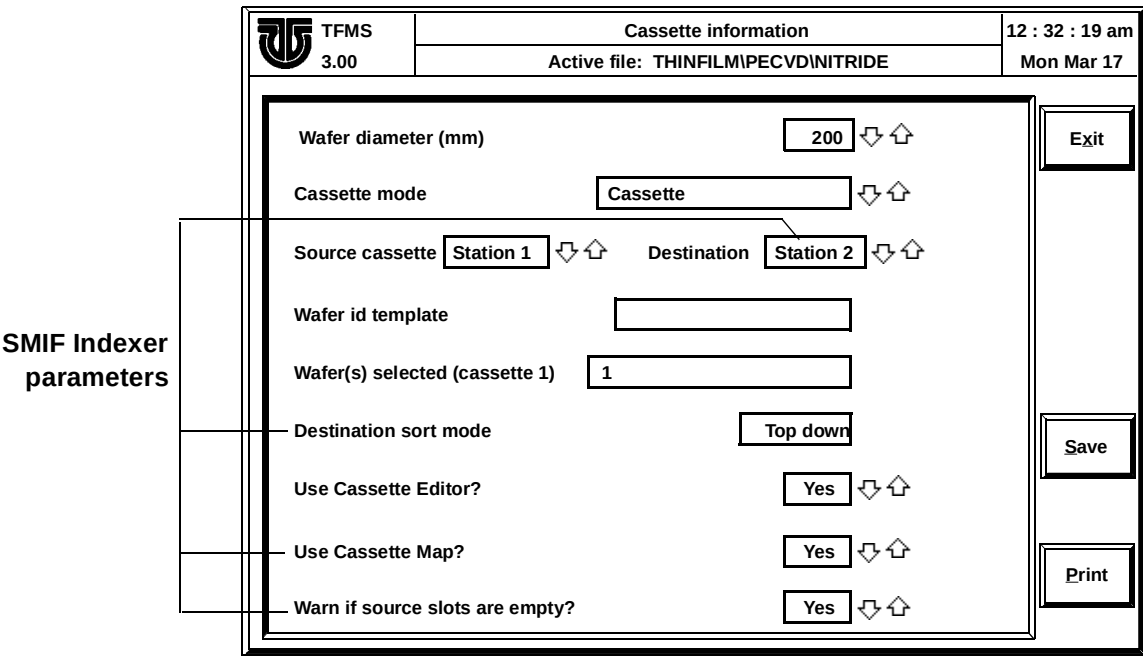


Cassette mode for SMIF Indexer systems

On SMIF Indexer equipped systems, you can set up additional cassette parameters, as shown in Figure 3.64. These parameters allow you to select different source and destination cassettes, sort wafers, and utilize wafer mapping.

When you select a destination cassette that is not the source cassette, the *Destination sort mode* field appears. When you select *Yes* for *Use Cassette Map*, the *Warn if source slots are empty?* field appears.

Figure 3.64 Cassette information window (SMIF Indexer system set up for a cassette map and different source and destination cassettes)



Destination cassette: When you select *Station 1* or *Station 2* as the *Source cassette*, and then select the *Destination* field, you can select either of these stations for unloading wafers. This is useful for process tools that require test wafers to be interleaved with product wafers in a cassette. After the system measures the test wafers, they can be unloaded to a destination reclaim cassette. If the job file is set up to display the Process Information window at run time, the operator can override the current job file setup for source and destination cassettes.

Destination sort mode: This parameter appears only if the Destination cassette is not the Source cassette. When you select *Destination sort mode*, two options appear, *Bottom up* and *Top down*. These options specify whether the robot unloads wafers into the destination cassette starting from the bottom of the cassette and moving up, or starting from the top of the cassette and moving down. The robot begins unloading wafers to the first available empty slot closest to the bottom or top of the cassette. If wafer mapping is not enabled (see below) the system responds as follows: If the Destination cassette station does not contain an

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empty cassette, a message tells the operator to load an empty destination cassette. If there are not enough empty slots in the destination cassette and the Source Cassette Editor appears at run time, the operator can modify the wafers to be measured or load an empty destination cassette. If the Source Cassette Editor does not appear at run time, the system aborts the measurement and a message tells the operator to load an empty destination cassette.

Use Cassette Map? This parameter specifies whether the system maps the cassette. Cassette mapping identifies the slots that contain wafers and the slots that are empty. If you select *Yes* for *Use Cassette Map?* the robot does not try to load wafers from empty slots, or to unload them into occupied slots. At run time, if the destination cassette station does not contain a cassette, a message tells the operator to load one. If the destination cassette station does not contain the required number of empty slots, and the Source Cassette Editor appears at run time, the operator can modify the wafers to be measured or load an appropriate Destination cassette. If the Source Cassette Editor does not appear, the system aborts the measurement and a message tells the operator to load a Destination cassette with the required number of empty slots.

Warn if source slots are empty? This parameter only appears if the above cassette mapping function is enabled. It specifies whether the system displays a message if any of the wafers designated for a measurement are not in their assigned slots. This message gives the operator the option of aborting the cassette measurement or continuing and skipping the slots with the missing wafers. If the Process Information window and/or the Source Cassette Editor window appear at run time, the operator can select alternate wafers to measure.

Source Cassette editor window at runtime: When wafer mapping is enabled and the active job file is set up to display the Source Cassette Editor window at run time, *No* appears in the Cassette Editor's *Measure* field(s) for each empty slot in the Source cassette. If a SMIF Indexer job file is set up to display a warning message when wafers designated for measurements are not in their assigned slots, this message appears before the Source Cassette Editor appears. After you confirm this message, the word "Empty" appears in the *Measure* field(s) for each slot that is missing a wafer.

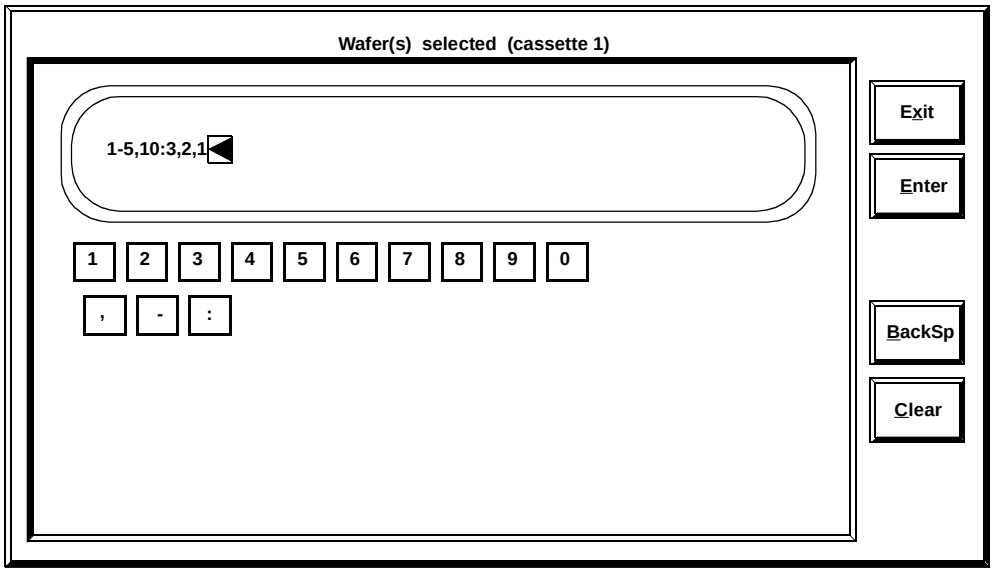
The system updates the Cassette map each time you place a wafer in the Destination cassette. If you move a cassette, the system invalidates the cassette map and you must begin another cassette loading operation if you want to create a new map.

Except for prompted replacement, if you move the Destination cassette during a cassette measurement, the system aborts the measurement process. If a wafer is left on the stage, a message asks you to load a cassette with an empty slot and specify that slot.

Wafer id template: In this field, you can enter a unique group of characters that you can use as a template for individual wafer id's in the Cassette editor window. The wafer id template contains the part of the wafer id that is the same for all the wafers in a cassette. For additional information on the Wafer id template, see "Cassette editor" in Section 2, "Operation Summary," and "Performing an automated cassette measurement" in your "Getting Started" manual. For information on entering a wafer id in single wafer mode, see "Setting up a production single wafer measurement" in the your "Getting Started" manual.

Wafer(s) selected (cassette 1/2): Specifies the job file's wafer measurement sequence by slot number. When you select this field, the Wafer(s) selected keyboard window appears, as shown in Figure 3.65. You use the characters in this window to enter one or more wafer sequence strings. A number indicates the wafer slot, a dash separates the beginning and end of a sequence string, a colon precedes the number of times to measure the wafer, and a comma separates sequence strings. For example, if you enter 1-5, 10:3, 2, 1, the system measures wafers 1 through 5, followed by wafer 10 measured 3 times, followed by wafer 2 and then wafer 1. You can measure up to 99 wafers in a measurement sequence (including repetitions).

Figure 3.65 Wafer(s) selected keyboard window



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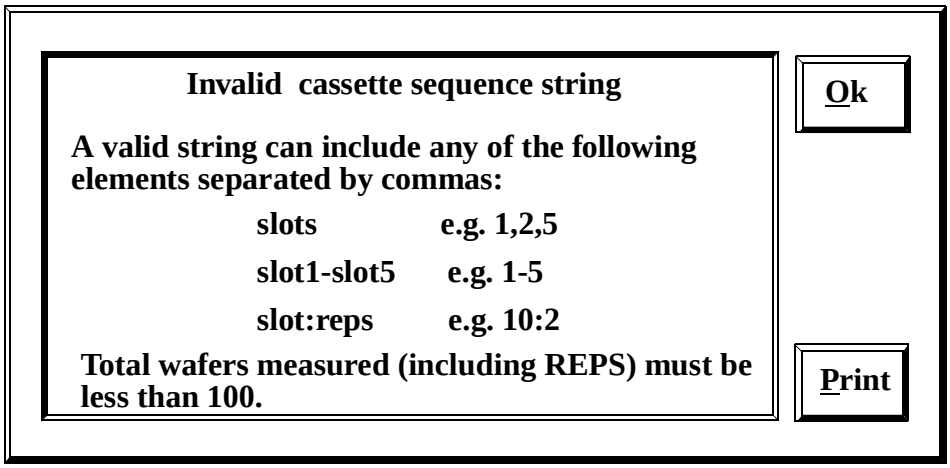
Wafer(s) selected (cassette 1/2):If you enter an invalid sequence string, a dialog box appears with a reminder message, as shown in Figure 3.66.

Figure 3.66 Invalid cassette sequence string dialog box


Invalid cassette sequence string
A valid string can include any of the following elements separated by commas:
slots e.g. 1,2,5
slot1-slot5 e.g. 1-5
slot:reps e.g. 10:2
Total wafers measured (including REPS) must be less than 100.
Ok
Print

For more information on entering a wafer sequence, see "Performing an automated cassette measurement" in the your "Getting Started" manual.

Use Cassette Editor?In this field, you can specify whether or not the Cassette editor window appears at run time.

3.7.4 Wafer

When you select *Setup*/*Recipe*/*Wafer*, the Wafer control parameters window appears. In this window, you enter specific characteristics of the wafers and the wafer loading parameters. When you disable center/flat find, the window looks like Figure 3.67. When you enable center/flat find, the window looks like Figure 3.68.

Figure 3.67 Wafer control parameters window (center flat find = No)

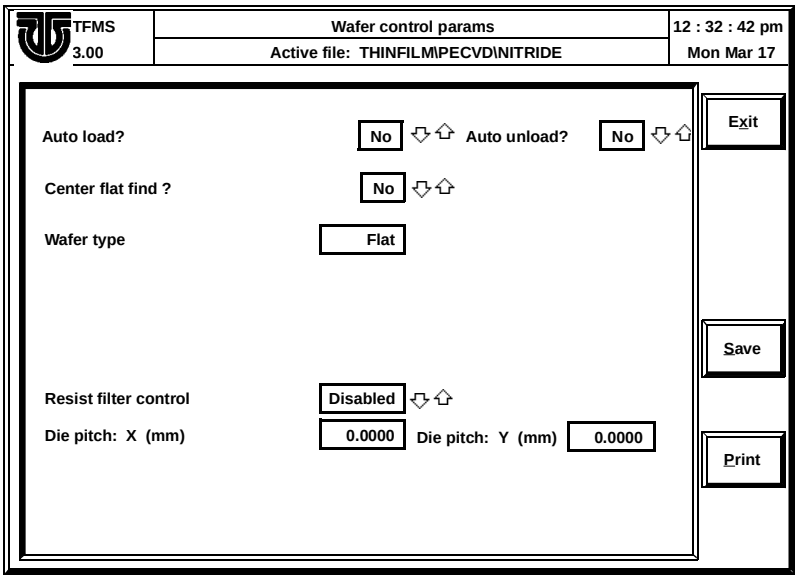
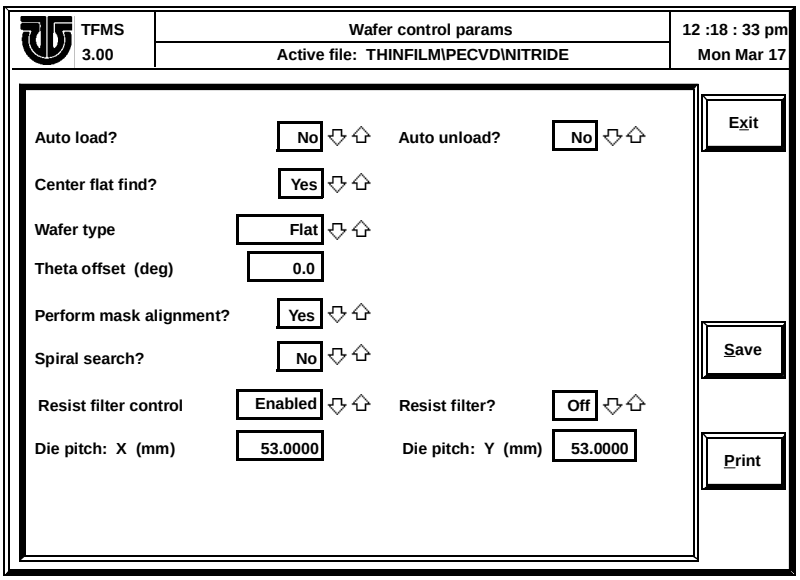


Figure 3.68 Wafer control parameters window (center flat find = Yes)



Auto load, Auto unload.

In these fields, you can indicate whether or not a wafer automatically loads before a manual measurement and automatically unloads after a manual measurement, for

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a job file set up in single wafer mode. When you perform an automated measurement in cassette mode, wafers always load and unload automatically at run time.

For manual measurements in cassette mode, if you select *No* for both fields, the wafer remains on the stage after each measurement, and you can perform repeated measurements without reloading. If you select *Yes* for both fields, the system automatically loads and unloads the wafer.

When you perform a measurement in single wafer mode, wafers never load automatically. You must enter a station and slot number in the dialog box that appears before the system measures a wafer. If you select *Yes* for Auto unload, the system unloads the wafer after a measurement. If you select *No*, the wafer remains on the stage after each measurement and you can perform repeated measurements without reloading.

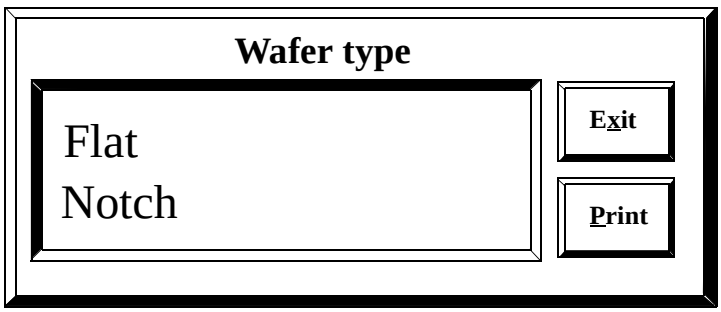
Center flat find

In this field, you indicate whether or not the system performs a center/flat find (pre-alignment) operation when loading a wafer. If you select *Yes*, the window looks like Figure 3.68, and the system finds the center of the wafer and orients the (major) flat or notch, depending on the wafer type (see below). If you select *No*, the window looks like Figure 3.67, and the system does not enable the center/flat find operation.

Wafer type

In this field you designate a wafer type that determines whether the center flat find operation aligns a flat or a notch. The options are shown in Figure 3.69. For flat alignments, if a wafer has two flats, the system aligns the major flat.

Figure 3.69 Wafer type pop-up menu

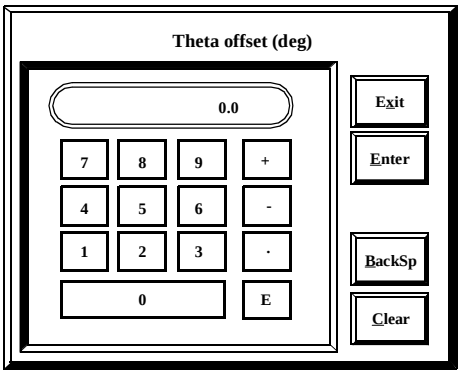


When your system is installed, Therma-Wave configure s SETUP\GENERIC\JOBFILE to correspond to the standard wafer size and type for your facility. Unless you're measuring a non-standard wafer, this field should default to the correct selection.

Theta offset (deg) [center flat find = Yes]

In this field, you can designate an angular offset adjustment, applied after the system performs a center/flat find operation. When the mask pattern is improperly aligned with the flat (notch), this type of adjustment may become necessary before mask alignment. When you select this field, a calculator window appears where you enter the desired value, as shown in Figure 3.70. The limits for this adjustment are -180° and 180°. If the theta offset is 0°, the major flat or notch is displayed facing down on the sample viewing monitor. The wafer shape on the TFMS monitor always shows a flat at the bottom, regardless of the theta offset.

Figure 3.70 Theta offset calculator window



Perform mask alignment? (center flat find = Yes)

In this field, you indicate whether or not the system performs a mask alignment (also called global alignment or de-skewing) when loading a wafer. This field only appears when center/flat find is enabled and a VP is installed). In addition, when you select *Yes* to enable mask alignment, the following conditions must be in place:

- A patterned wafer is being measured.
- Mask alignment sites have already been taught.
  (See "Mask teach" in Section 4, "Pattern Recognition Functions.")

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Spiral search? (center flat find = Yes, Perform mask alignment = Yes)

In this field, you specify whether or not the stages move in a spiral pattern during mask alignment when mask alignment sites are not visible in the field of view. This field only appears when center/flat find and mask alignment are enabled and a vision processing system is installed. This operation searches neighboring fields of view covering an area equal to about three times the field of view (Therma-Wave can increase to 8 times the field of view).

Resist filter control

This parameter allows you to enable or disable control of the resist filter for the active job file. When you enable *Resist filter control*, another parameter appears, *Resist filter?*, as shown in Figure 66. This parameter does not appear when *Resist filter control* is disabled. When you select *Resist filter*, two options appear, *On* and *Off*. By selecting one of these options, you can override the system's current default setting by inserting (*On*) or removing (*Off*) the resist filter, located in the white light path. The white light allows you (and the vision processor, if installed) to see the pattern on a patterned wafer. You use the resist filter for samples with unexposed photoresist because it blocks the high frequency (short wavelength) components of the white light that would otherwise expose the resist. The resist filter blocks all wavelengths below 460 nm.

Die Pitch: X (mm), Die pitch: Y (mm)

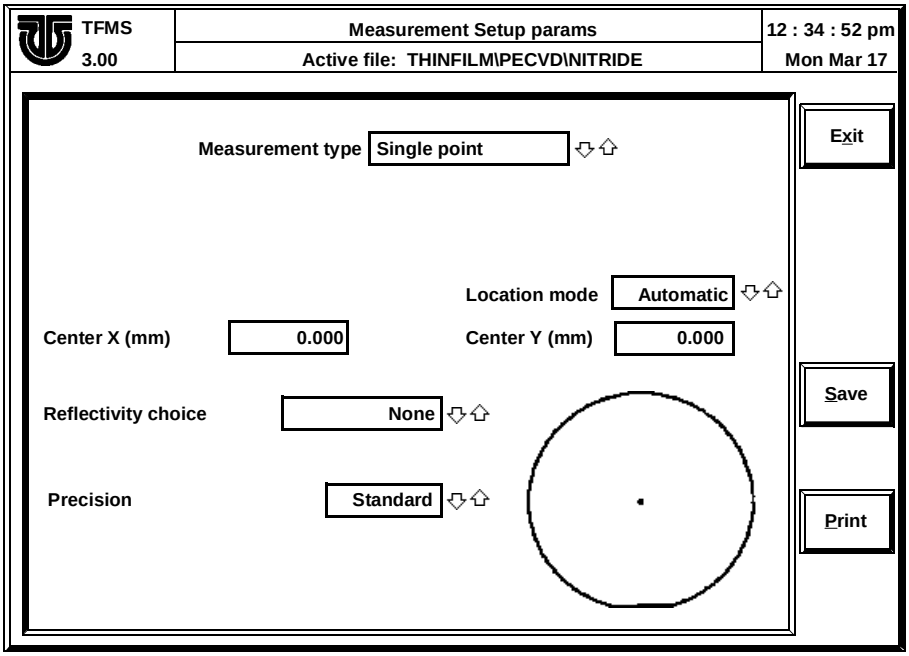
In these fields, you enter the X and Y die dimensions in millimeters. These are repeat dimensions, so they include the scribe line in addition to the die. The step sizes in the Stage locator's scroll bars use these dimensions, which are applicable for both patterned and unpatterned wafers (See your "Getting Started" manual). These fields are identical to the fields that appear in the Mask teach VP parameters window, described in Section 4, "Pattern Recognition Functions." When you select either of these fields, a calculator window appears where you enter the desired value.

3.7.5 Measurement

When you select *Setup*/*Recipe*/*Measurement* , the Measurement Setup parameters window appears. This window looks different for each measurement type. When you select *Single point* in the *Measurement type* field, the Measurement Setup parameters window looks like the example in Figure 3.71. Figures 3-78, 3-82, 3-84, and 3-88 show Measurement Setup parameters windows for the four other measurement types. The measurement parameters define the data collection

operation (e.g. number and location of measurement sites) rather than the data processing or data display operations.

Figure 3.71 Measurement Setup parameters window (single point)

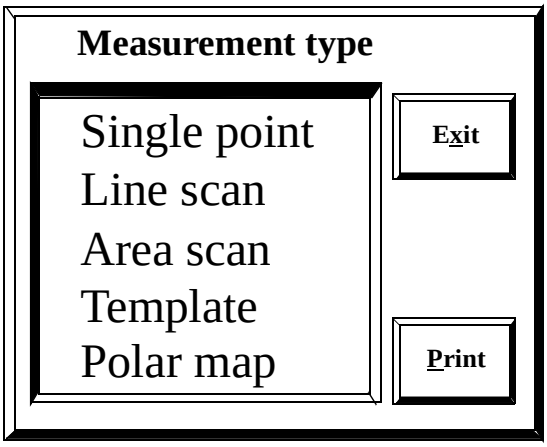


Overview of measurement setup parameters

Several measurement setup parameters have similar meanings for more than one measurement type. Following is a description of these parameters, followed by additional information for each measurement type.

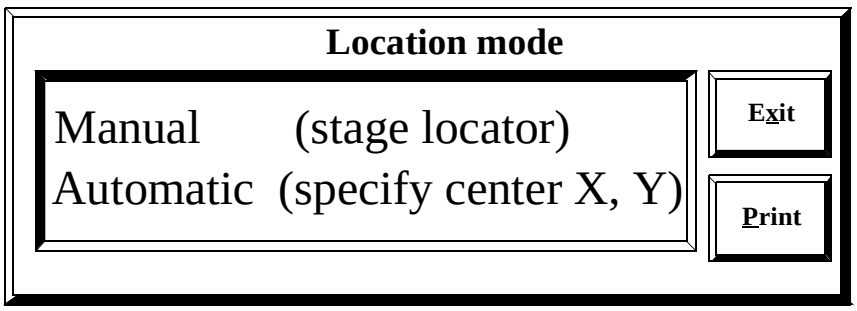
Measurement type: Specifies the type of measurement performed by the system. When you select this field, a pop-up menu appears with five options, as shown in Figure 3.72.

Figure 3.72 Measurement type pop-up menu



Location mode : Specifies the method used to position the measurement site(s). When you select this field, two options appear in a pop-up menu, as shown in Figure 3.73.

Figure 3.73 Location mode pop-up menu



When you select *Manual*, the operator uses the Stage locator to position the measurement. When you select *Automatic*, the system automatically positions the measurement(s) and the Stage locator does not appear during the measurement sequence. For a template measurement, you use the Stage locator to position each point. For a line scan, area scan, or polar map you use the Stage locator to position the center/middle point only.

Center X, Center Y (mm): specify the measurement location when the location mode is automatic. When you select either of these fields, a calculator window appears where you enter the desired value. The system ensures that all measurement sites are located within the wafer diameter by reducing the measurement area when necessary, e.g., line length or area scan diameter.

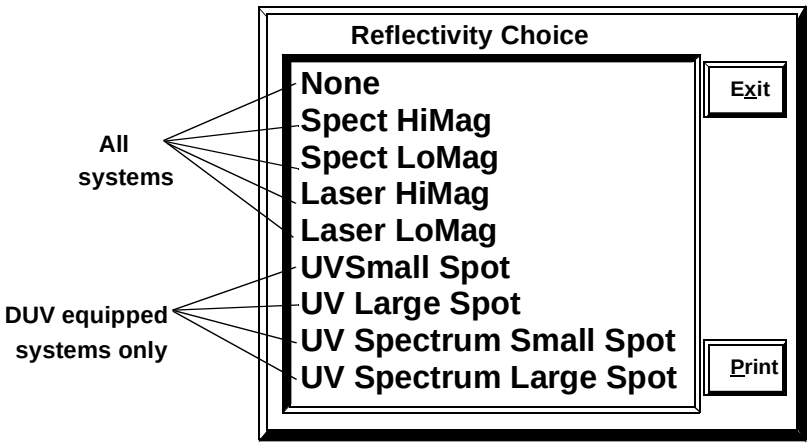
Size (mm): specifies the length of a line scan or the diameter of an area scan, polar map, or standard template. The size and center location interact to ensure that all measurement sites are within the wafer diameter. However, the system can position a site beyond a flat.

Edge exclusion: specifies the distance between the outermost measurement site and the edge of the wafer, excluding any flat(s). You use this parameter for line scans, area scans, polar maps, and standard template measurements centered at X=0, Y=0. When the *Size* and *Edge exclusion* fields both appear in the window, you can change either parameter and the system automatically calculates the other.

Reflectivity choice: specifies whether the system measures film reflectivity, and if so, how this type of measurement is performed. If you enable this function, the Opti-Probe measures film reflectivity at the specified wavelength for all measurement points, sites, or locations, but does not measure the thickness, index, or extinction coefficient.

Figure 3.74 shows the Reflectivity choice pop-up menu.The first five options function on all systems. The last four options function on DUV equipped systems only and are described in Section 5, "DUV Functions."

Figure 3.74 Reflectivity choice pop-up menu



None:When you select this option, the system does not perform reflectivity measurements.

Spect HiMag, Spect LoMag:When you select this option, the system measures reflectivity in either high or low magnification using the spectrometer. The spectrometer uses a broad wavelength band.

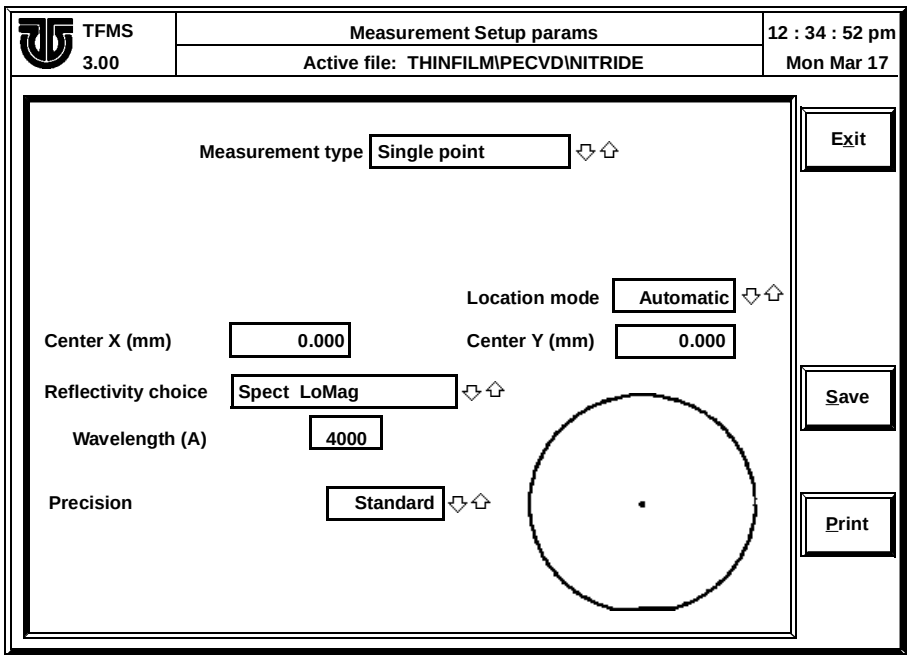
Laser HiMag, Laser LoMag:When you select this option, the system measures reflectivity in either high or low magnification using the laser diode. The laser diode uses a single wavelength.

The LoMag modes provide no practical advantage unless you're comparing the Opti-Probe to another type of metrology tool. The useful spot size area is larger in LoMag mode (size ratio ~ 16) than in HiMag mode.

UV Small Spot, UV Large Spot,
UV Spectrum Small Spot, UV Spectrum Large Spot:These options are only functional on DUV equipped systems and are described in Section 5, "DUV Functions."

After you enable a reflectivity measurement, the *Wavelength (A)* field appears where you enter the desired wavelength for the reflectivity measurement, as shown in the example in Figure 3.75.

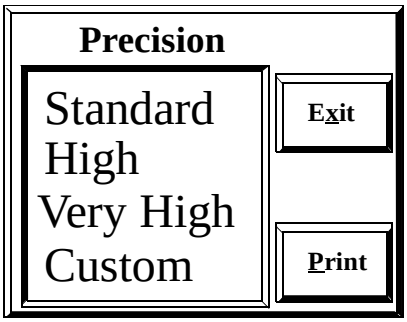
Figure 3.75 Measurement Setup parameters window (after selecting a reflectivity option)



Precision:specifies whether the system performs a high precision measurement at run time. If you set up your job file for a high precision measurement, you can force the system to perform an autocalibration before each measurement. Although this type of measurement requires additional time, it provides you with greater control over the repeatability of the measurement results, eliminating the slightest variation in the system. When you select

the *Precision* field, a pop-up menu appears with four options, as shown in Figure 3.76.

Figure 3.76 Precision pop-up menu



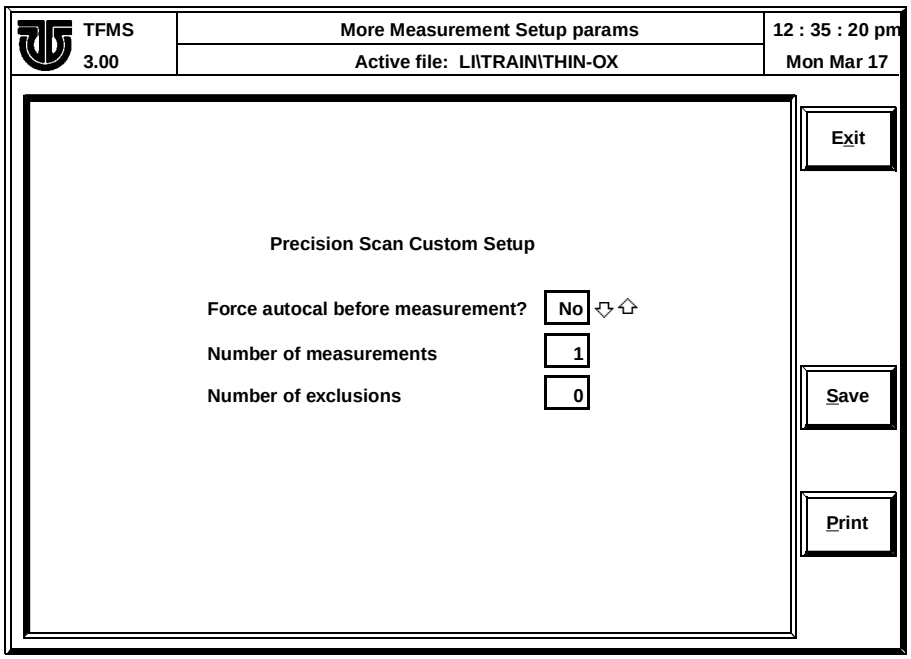
Standard:Specifies a standard measurement instead of a high precision measurement.

High:Specifies an autocalibration before each measurement.

Very High:Specifies that the system performs an autocalibration before a measurement, repeats the autocalibration and the measurement six times, and excludes the highest and lowest measurement results for each parameter measured, averaging the remaining four measurement results.

Custom:When you select *Custom*, a *More* button appears in the Measurement Setup parameters window's right margin. When you select the *More* button, the More Measurement Setup parameters window appears, as shown in Figure 3.77. In this window, you can customize a precision measurement.

Figure 3.77 More Measurement Setup parameters window



Force autocal before measurement? Specifies whether or not the system performs an autocalibration before each measurement.

Number of measurements: Specifies the number of times the system repeats the measurement.

Number of exclusions: Specifies the number of measurement results that the system excludes when averaging the measurement results (at least one measurement result must remain after the exclusion).

When you enter 1, the system excludes the highest and lowest measurement results (a minimum of three measurements must be performed).

When you enter 2, the system excludes the two highest and two lowest measurement results (a minimum of five measurements must be performed).

Uniform film optimization: Enables or disables an advanced measurement algorithm called uniform film optimization (UFO). This algorithm is useful in

some situations for multiple-parameter measurements if any parameter other than (top) film thickness is uniform across the wafer but varies from wafer to wafer. The system implements the UFO algorithm somewhat differently for spectrometer and non-spectrometer measurements. The main reason for using UFO is to improve throughput for spectrometer measurements so the spectrometer measures only one site on the wafer (generally near the center) to select the cycle for the (top) film thickness. Following this spectrometer measurement, the system uses a thickness tracking algorithm to calculate the measured parameters for the other measurement sites. UFO is not selectable for single point measurements. When you select this field, two options appear. You select the *Resolve* option to apply UFO, and the *No* option to disable UFO.

Wafer shape: The wafer shape, located at the lower right side of the window, shows the measurement site locations for the current measurement setup. Each site is identified by a small box except in a few setups where the sites are numbered (e.g., templates with fewer than 17 measurement sites). The flat at the bottom of the wafer shape does not represent the actual flat or notch position.

Single point measurement setup

When you select *Single point* in the Measurement type field, the Measurement Setup parameters window looks like the example in Figure 3.71. This measurement is performed at one selected point on the wafer. The result is the value(s) of the measured parameter(s) for that point.

Location mode: Specifies the method used to position the measurement site. When you select *Manual*, the operator uses the stage locator to position the measurement at run time. When you select *Automatic*, the system automatically positions the measurement site at the coordinates entered for center X and center Y.

Center X, Center Y (mm): Specify the X and Y coordinates used when the location mode is automatic. The system ensures that the measurement site is within the wafer diameter.

Line scan measurement setup

When you select *Line scan* in the Measurement type field, the Measurement Setup parameters window looks like the example in Figure 3.78. This measurement is a vertical or horizontal line with a specific size and number of points you enter in this window.

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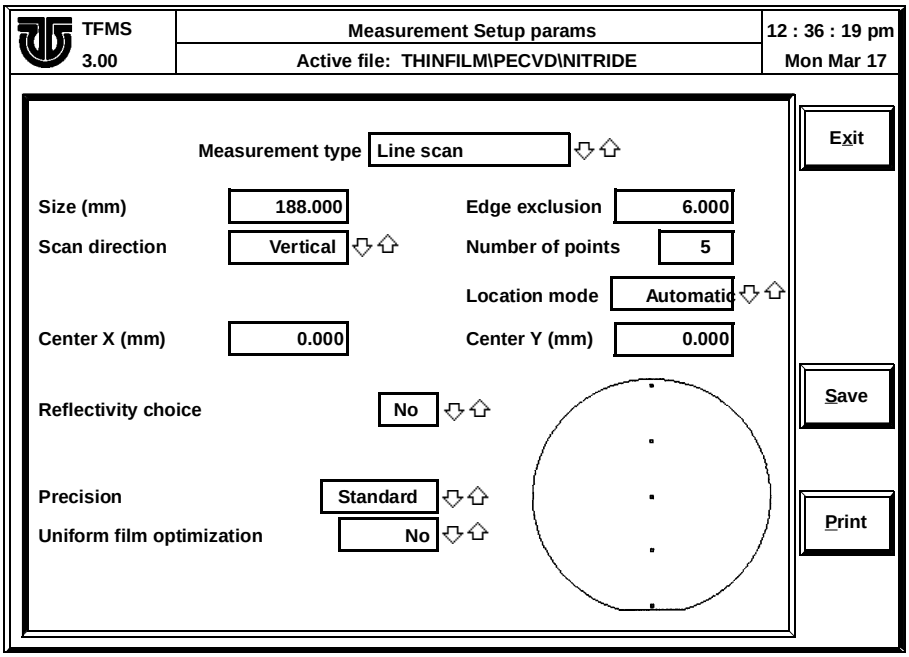
Figure 3.78 Measurement Setup parameters window (line scan)

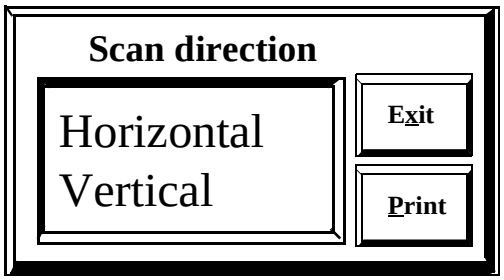


Size (mm): Specifies the length of the line scan in millimeters. The maximum size is determined by the wafer diameter and the current center X and Y coordinates.

Edge exclusion: Specifies the distance between the line scan's end points and the edge of the wafer, when the center x and y coordinates are both zero. When this field appears, you can adjust either the length of the line scan or the edge exclusion, and the system automatically calculates the other value.

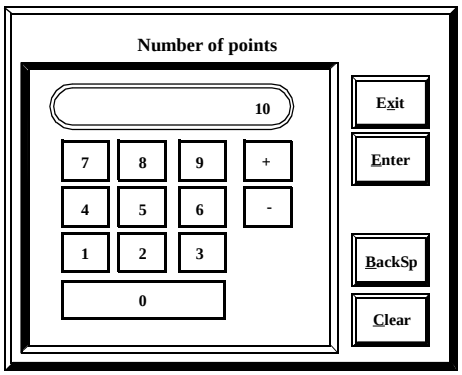
Scan direction: Specifies the direction of the line scan (vertical or horizontal); it is not applicable for other measurement types. When you select this field, the two options appear in a pop-up menu, as shown in Figure 3.79.

Figure 3.79 Scan direction pop-up menu



Number of points :Specifies the number of points in a line scan; it is not applicable for other measurement types. When you select this field, a calculator window appears, as shown in Figure 3.80, where you enter the desired value. The number of points can range from 2 to 625.

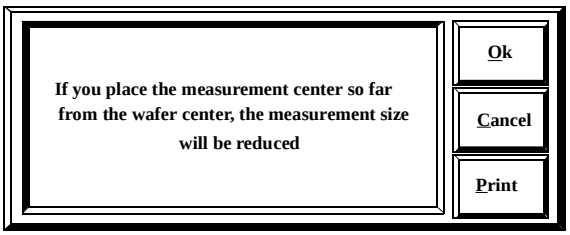
Figure 3.80 Number of points calculator window



Location mode:Specifies the method used to position the measurement. When you select *Manual*, the operator uses the Stage locator to position the center of the line scan at run time. When you select *Automatic*, the system uses the center X and center Y coordinates (that you specify in this window) as the middle of the line.

Center X, Center Y (mm):Specify the X and Y coordinates used for the center of the line scan when the location mode is automatic. The system ensures that the entire line scan remains within the wafer diameter. If you enter a center x or y coordinate that places either end of the line scan outside the wafer diameter, a dialog box appears, as shown in Figure 3.81.

Figure 3.81 Measurement outside wafer diameter dialog box



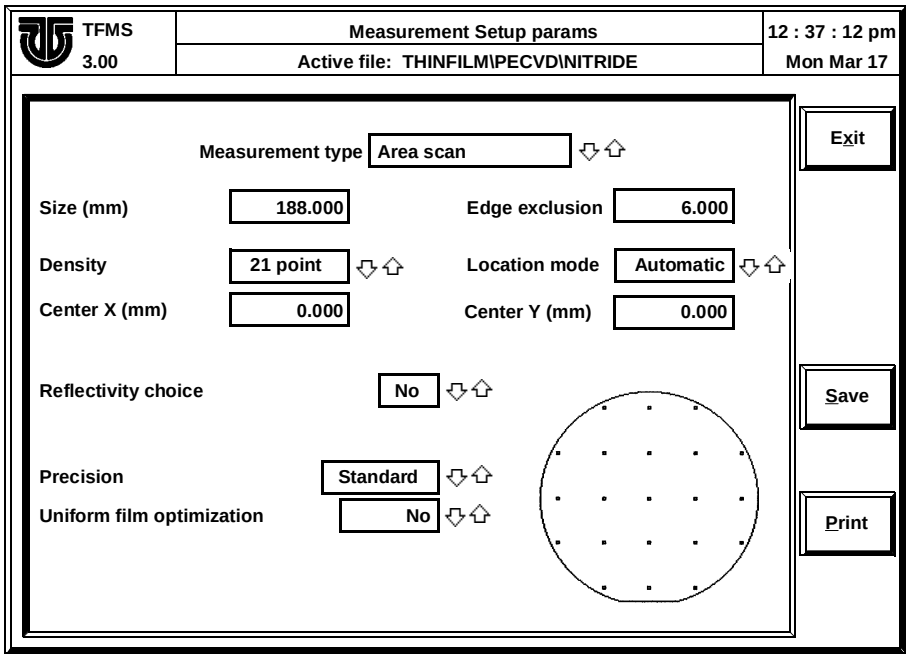
If you select *Ok* in the dialog box, the system reduces the size so that the entire line scan remains within the wafer diameter. After selecting *Ok*, if you return the center

X and center Y coordinates to zero, the system uses the new (reduced) size and calculates the edge exclusion accordingly. If you select *Cancel*, the system uses your previous x or y coordinate entry.

Area scan measurement setup

When you select *Area scan* in the Measurement type field, the Measurement Setup parameters window looks like the example in Figure 3.82. This measurement uses an array of points equally spaced vertically and horizontally. The outline of the array is approximately circular. You can specify the diameter (size) of the scan and the number of points (or density) by making entries in their respective fields in this window.

Figure 3.82 Measurement Setup parameters window (area scan)



Size (mm): Specifies the diameter of the area scan in millimeters. The maximum size is determined by the wafer diameter and the current center X and Y coordinates.

Edge exclusion: Specifies the distance between the area scan's outermost points and the edge of the wafer, when the center x and y coordinates are both zero. When this field appears, you can adjust either the diameter (size) of the area scan or the edge exclusion, and the system automatically calculates the other value.

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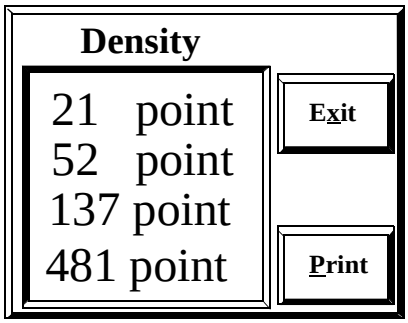
Density :Specifies the number of points for an area scan; it is not applicable for other measurement types. When you select this field, a pop-up menu appears with four options, as shown in Figure 3.83.

Figure 3.83 Density pop-up menu



Location mode:Specifies the method used to position the measurement. When you select *Manual*, the operator uses the Stage locator to position the center of the area scan at run time. When you select *Automatic*, the system uses the center X and Y coordinates (that you specify in this window) as the center of the area scan.

Center X, Center Y (mm):Specify the X and Y coordinates used for the center of the area scan when the location mode is automatic. The system ensures that the entire area scan remains within the wafer diameter. If you enter a center X or Y coordinate that places the edge of the area scan outside the wafer diameter, a dialog box appears, as shown in Figure 3.80. If you select *Ok* in the dialog box, the system reduces the size so that the entire area scan remains within the wafer diameter. After selecting *Ok*, if you return the center X and center Y coordinates to zero, the system uses the new (reduced) size and calculates the edge exclusion accordingly. If you select *Cancel*, the system uses your previous x or y coordinate entry.

Template measurement setup

When you select *Template* in the Measurement type field, the Measurement Setup parameters window looks similar to the example in Figure 3.84 for a die template. Template measurements use a pattern of measurement points. The pattern can be a TWI defined standard template or a user defined custom template or die template. For information on creating a custom template, see *Custom Template*/*Site teach* and *Library*/*Custom template* later in this section. For information on creating a die template and VP related information on custom templates, see Section 4,

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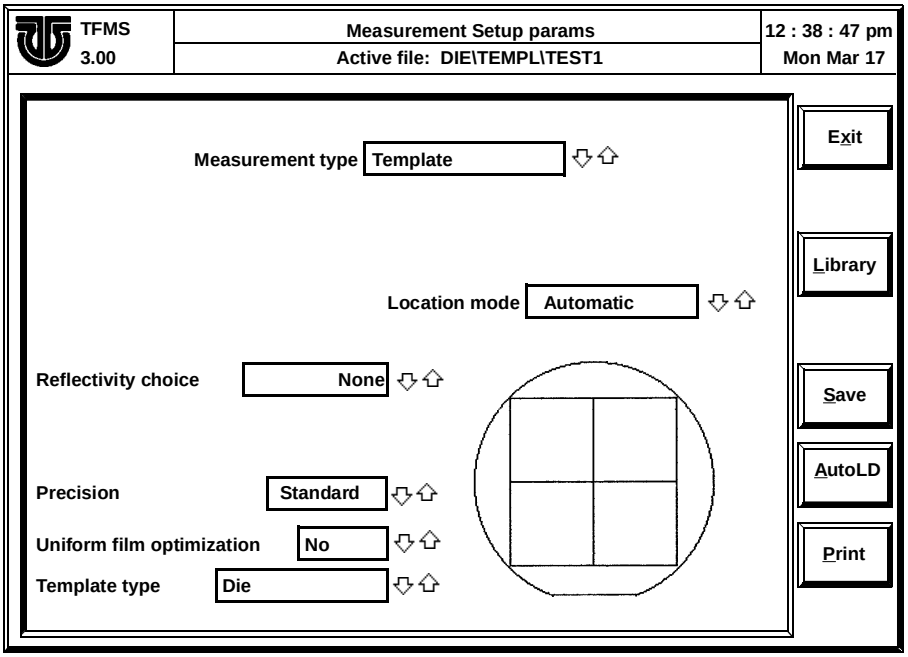
"Pattern Recognition Functions." The *Autoload* button only appears for custom and die template measurement types, and is described later in this section.

The *Die* option only functions on systems with a VP installed.

Figure 3.84 Measurement Setup parameters window (die template)

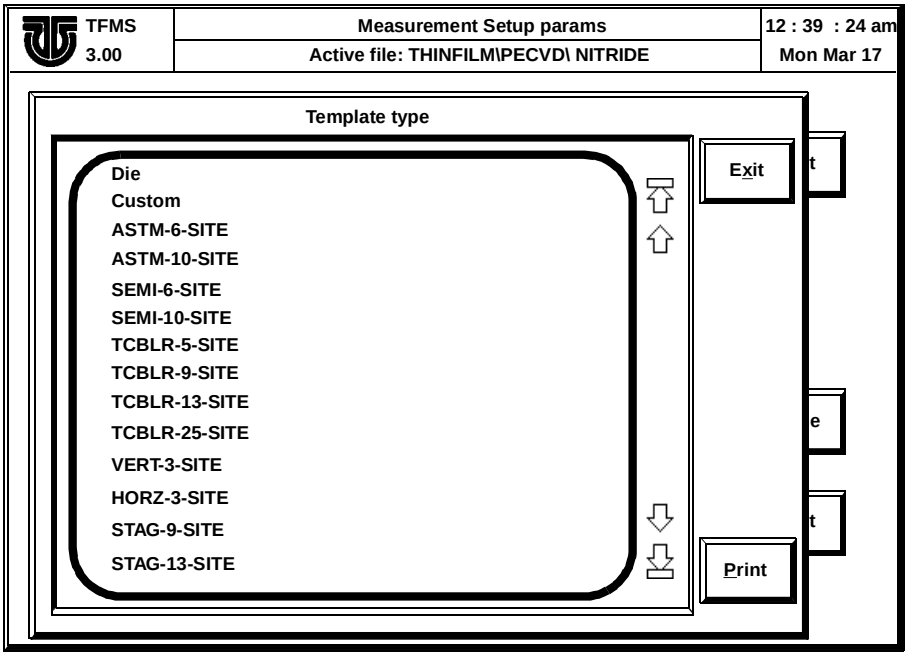


Location mode: Specifies the method used to position the measurement at each template site. When you select *Manual*, the stage locator appears at run time for each measurement site so the operator can "fine tune" the location of each point. When you select *Automatic*, the system uses the measurement site coordinates specified in a file associated with the template.

Template type : When you select this field, the Template type window appears with a list of options, as shown in Figure 3.85. The scrolling arrows work like

those in the Open window (See "Scrollable list windows" in your "Getting Started" manual).

Figure 3.85 Template type window



Die and custom templates (user defined): If you select *Die* or *Custom* in the Template type window, the Measurement Setup parameters window reappears with *Die* or *Custom* displayed in the *Template type* field, and the *Autoload* button appears in the window's right margin, as shown in Figure 3.86. After selecting a *Die* or *Custom* template type, you can use a library template or create a new template.

To use a library template select the *Library* button in the Measurement setup parameters window. The *Library* button opens the Die template or Custom template library window where you select from a list of die templates or custom templates. After you select the desired die or custom template, the Measurement setup parameters window reappears with your selection displayed on the wafer shape. To create a new template first select the exit button and then select *setup*/*Recipe*/*Die template* or/*Custom template* . For more information on setting up a Die template, see Section 4, "Pattern Recognition Functions." For more information on setting up a Custom template, see *Custom template* later in this section.

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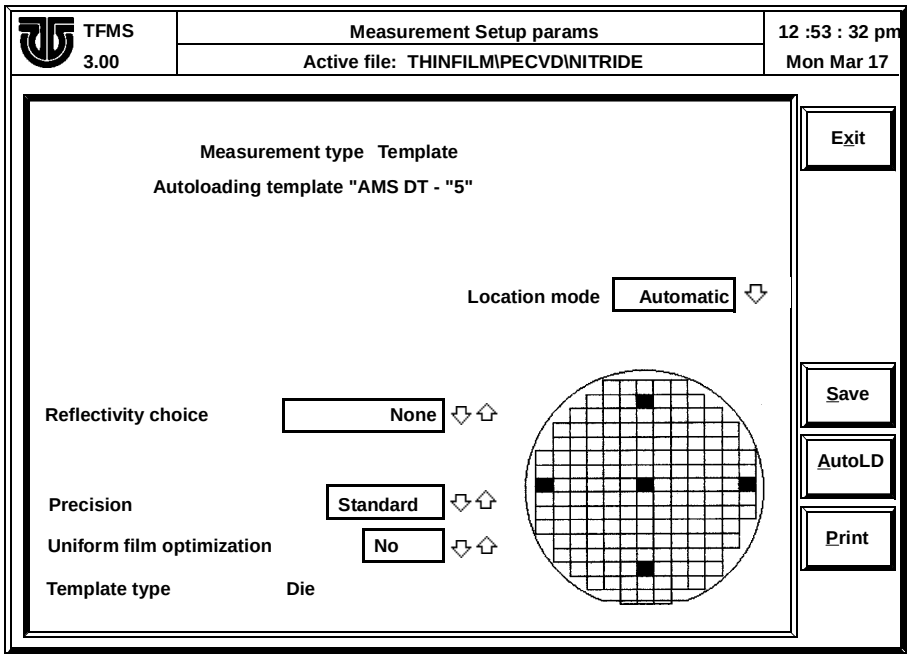
AutoLD button: When you select this button, the Die template or Custom template Library window appears where you select the desired template entry. After you select a library entry, the Measurement Setup parameters window displays non-selectable (view-only) template related fields, the name of the autoloading template appears below the measurement type, and the *Library* button is not displayed, as shown in [1]. In this mode, the system loads this template setup each time a user opens the job file. To return to normal operations and cancel autoloading, the owner of the job file or another authorized user must re-select the *AutoLD* button.

Figure 3.86 Measurement Setup parameters window (with autoloading enabled)



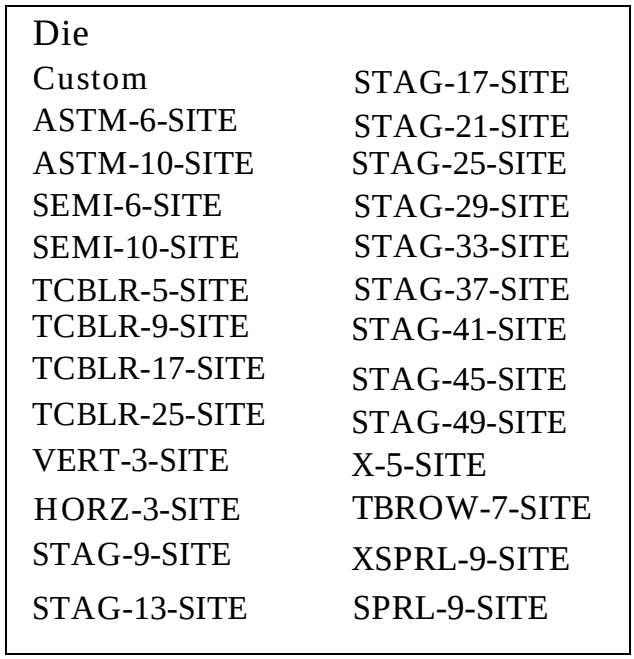
If autoloading is enabled, you can not perform a *Check out* operation in the corresponding library maintenance window.

Standard templates (TWI defined): The list of standard templates follows the *Die* and *Custom* options. The standard templates are scalable and centered on the wafer. Each standard template name contains an abbreviated description of the pattern type and the number of measurement sites. (ASTM = ASTM standard, SEMI = SEMI standard, TCBLR = top-center-bottom-left-right, VERT = vertical,

1.

HORZ = horizontal, STAG = staggered, X = x shaped, TBROW = top, bottom row, SPRL = spiral, XSPRL = x and spiral. Figure 3.87 lists all the TWI standard templates. Appendix C shows pictures of all the standard template patterns

Figure 3.87 TWI standard templates



If you select one of the standard templates in the Template type window, the Measurement setup parameters window reappears with your selection displayed in the *Template type* field and depicted on the wafer shape. For templates with fewer than 17 sites, each site is numbered on the wafer shape. For templates with 17 or more sites, each site is represented by a small box. In addition, two more fields appear in the Measurement setup parameters field, *Size* and *Edge* exclusion, as described below. The *Library* button and related text do not appear for standard templates.

Size (mm):Specifies the diameter of the pattern in millimeters, for a standard template. The maximum size is the wafer diameter. This field does not appear when you select a custom template. See "Template type" on the next page.

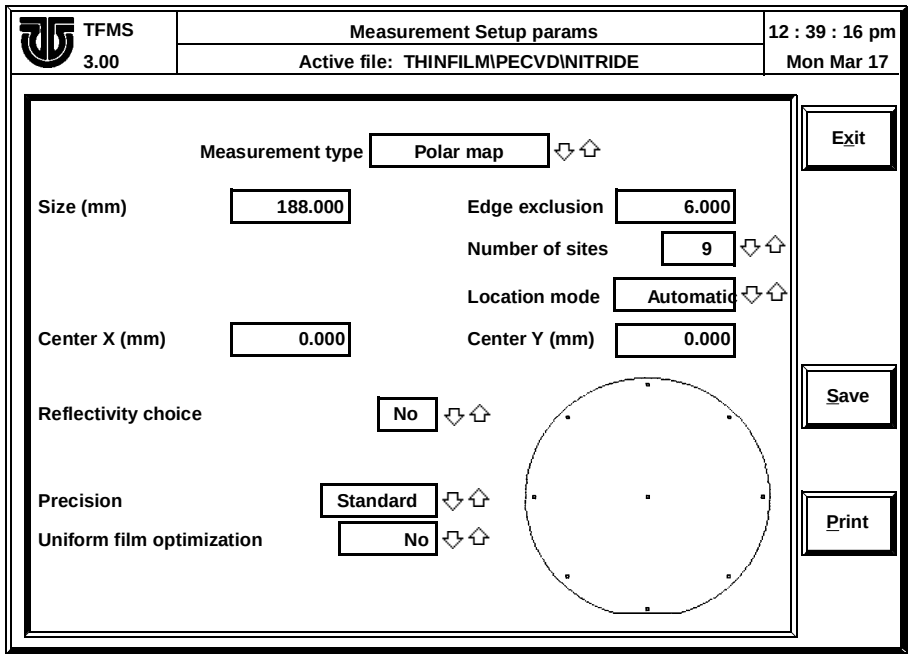
Edge exclusion:Specifies the distance between a standard template's outermost points and the edge of the wafer. When this field appears, you can adjust either the diameter (size) of the template or the edge exclusion, and the

system automatically calculates the other value. This field does not appear when you select a custom template. See "Template type" on the next page.

Polar map measurement setup

When you select *Polar map* in the Measurement type field, the Measurement Setup parameters window looks like the example in Figure 3.88. This measurement includes points located on uniformly spaced concentric circles and one point at the center of the circles. The innermost circle contains eight sites, the second circle contains 16 sites, and the n'th circle contains 8 x n sites. The sites are spaced uniformly in azimuth on each circle. All the circles have a site on each of the radii oriented at 0°, ± 45°, ± 90°, azimuth.

Figure 3.88 Measurement Setup parameters window (polar map)



Size (mm): Specifies the diameter of the outer circle of the polar map in millimeters. The maximum size is determined by the wafer diameter and the current center X and center Y coordinates.

Edge exclusion: Specifies the distance between the polar map's outermost points and the edge of the wafer, when the center X and Y coordinates are both zero. When this field appears, you can adjust either the diameter (size) of the polar map or the edge exclusion, and the system automatically calculates the other value.

Number of sites: Specifies the number of measurement sites for a polar map; it is not applicable for other measurement types. When you select this field, a pop-up menu appears, as shown in Figure 3.89. The table in Figure 3.90 lists the number of sites and the number of circles in the pattern.

Figure 3.89 Number of sites pop-up menu

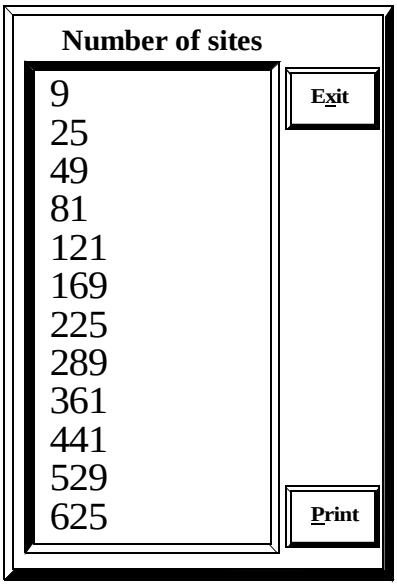


Figure 3.90 Number of polar map measurement sites

Circles	Sites in outer circle	Measurement sites
1	8	9
2	16	25
3	24	49
4	32	81
5	40	121
6	48	169
7	56	225
8	64	289
9	72	361
10	80	441
11	88	529
12	96	625

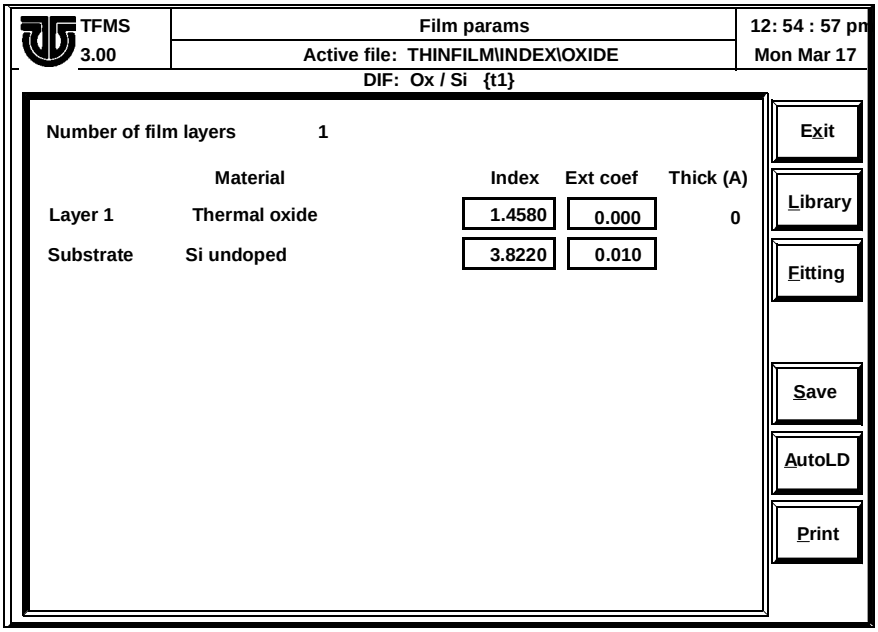
Location mode: Specifies the method used to position the measurement. When you select *Manual*, the operator positions the center of the polar map at run time. When you select *Automatic*, the system uses the specified center X and center Y coordinates to position the center of the polar map, as described below.

Center X, Center Y (mm): Specify the X and Y coordinates used to position the center of the polar map when the location mode is automatic. The system ensures that the entire polar map remains within the wafer diameter. If you enter a center X or Y coordinate that places the edge of the polar map outside the wafer diameter, a dialog box appears, as shown earlier in Figure 3.81. If you select *Ok* in the dialog box, the system reduces the size so that the entire polar map remains within the wafer diameter. After selecting *Ok*, if you return the center X and center Y coordinates to zero, the system uses the new (reduced) size and calculates the edge exclusion accordingly. If you select *Cancel*, the system uses your previous X or Y coordinate entry.

3.7.6 Film

When you select *Setup*/*Recipe*/*Film*, the Film parameters window appears, as shown in Figure 3.91. In some cases, a System Manager may remove Engineer level access to this window and its functions. If you select *Film* and do not have the necessary access privileges, a message informs you of this. In this window, you select the film stack you want to measure and the corresponding measurement parameters. This window defines the film stack and lists the Film stack params (known parameters), which are fixed during the measurement. *Library* , *Fitting* and *Autoload* buttons appear in the right margin. You can save your entire film setup by selecting the *Save* button in this window. If your job file is set up for a reflectivity measurement, the *Fitting* button and the *Index*, *Ext coef* , and *Thick (A)* parameters are not applicable, and do not appear in the window.

Figure 3.91 Film parameters window (Engineer level)



Whenever you set up a job file, it is advisable to start with an existing job file that is similar to the one you'd like to create. The most important characteristics to carry over to the new job file are the film stack and custom or die template pattern (if used). This approach saves you time and effort by eliminating the need to re-configure the parameters in the new job file that have the same entries as those in the original one. Therma-Wave provides a generic setup in the job file SETUP\GENERIC\JOBFILE, as well as a library of standard film stacks and measurement parameters (See *Library* button, later in this section). If you don't find your film stack in the film library, contact Therma-Wave Applications staff for assistance.

The entries in this window are somewhat simpler at the Engineer level than they are at the System Expert level. When you select a film stack, several setup parameters are view-only (not editable) at the Engineer level.

Number of film layers

Specifies the number of film layers in your stack, and is a view-only at the Engineer level.

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Material - Film layer(s), Substrate

Specify the films in the stack as well as the substrate, and are view-only for Engineer level User IDs. To select a new film stack, see the description of the *Library* button, later in this section.

Film stack params - Index, Ext coef, Thick (A)

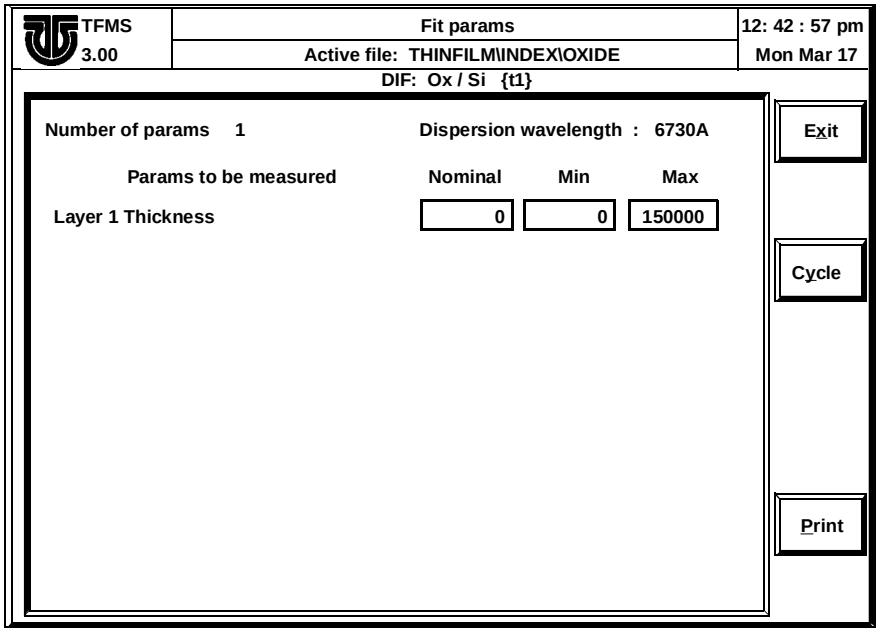
The optical constants (index of refraction, extinction coefficient) and thickness(es) shown in the upper portion of the window are fixed (not measured). When you select a film stack, the system obtains the default optical constants from the film and substrate libraries. These values correspond to the measurement wavelength (6730-6790 Å) and are appropriate for most applications.

You must enter values for film thicknesses that are fixed (i.e., not measured) for your job file. To edit a value, select the corresponding field. A calculator window appears where you enter the desired value. The System Manager can configure the system to display all thicknesses in either angstroms or nanometers.

Fitting button

When you select *Setup*/*Recipe*/*Film*/*Fitting*, the Fit parameters window appears, as shown in Figure 3.92. This window displays the *Params to be measured*, their nominal values, and fitting ranges. A *Cycle button* appears in the right margin. You also see the Dispersion wavelength displayed. This is the wavelength at which the current Opti-Probe reports the calculated N and K values.

Figure 3.92 Fit parameters window



Number of params: Specifies the number of parameters to be measured and is view-only at the Engineer level. Some film stacks have multiple entries in the film library, e.g., one- and two-parameter measurements. See the *Library* button later in this section. Be sure to select the desired parameter combination from the film stack list.

Params to be measured: Specify the parameters to be measured, and are view-only at the Engineer level. Some film stacks have multiple entries in the film library, e.g., thickness only and thickness and index, as described later in this section under the *Library* button. Be sure to select the desired parameter combination from the film stack list.

Nominal, Min, Max: Specify a nominal value and a range for each measured parameter. In most situations, the default nominal, minimum, and maximum values are adequate. It is not necessary to enter a nominal value for the thickness of a single film or for the top layer of a stack. You should enter correct nominal values for the parameters to be measured for the bottom layers in multi-layer films.

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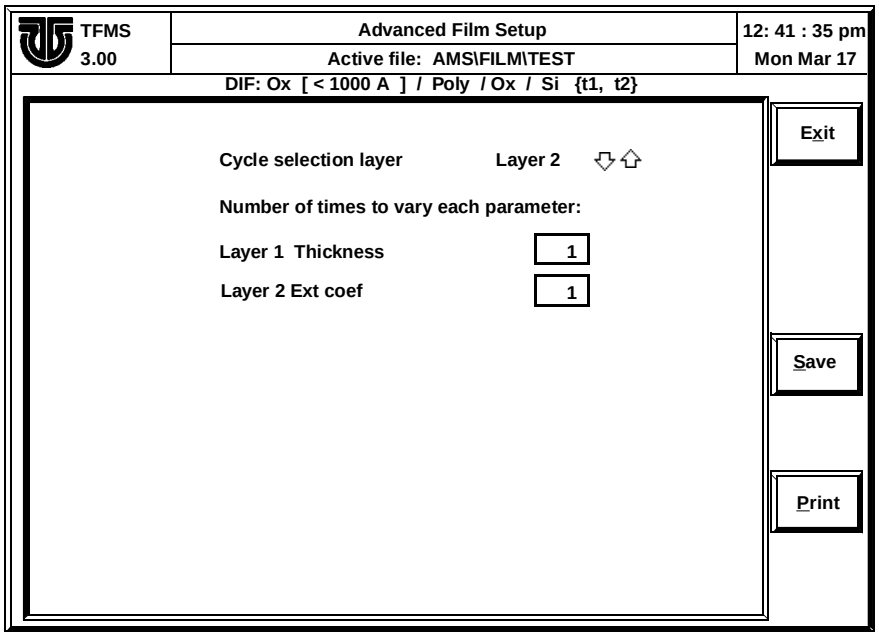
When you select any of these fields, a calculator window appears where you enter the desired value.

The measurement result always falls between the minimum and maximum values. Occasionally, the measured data and the film setup may be so inconsistent that the fitting routine cannot find a good fit within the specified range(s). When this happens, the Residual and Goodness of Fit (GOF) have bad values. For more information on Residual and GOF, see Section 2, "Operation Summary." Make sure you selected the correct film stack and specified the appropriate ranges. If you're still having trouble with your measurement, contact Therma-Wave Applications staff for assistance.

Cycle button: When you select the *Setup*/*Recipe*/*Film*/*Fitting*/*Cycle* button, the Advanced Film Setup window appears, as shown in the example in Figure 3.93. In this window, you can specify how the fitting routine varies the cycle selection measurement parameter(s) between the minimum and maximum values to find the correct value(s). If the only measured parameter is the (top) film thickness, this window only displays the cycle selection layer. Figure 3.93 shows an example of this window when DIF: Ox [< 1000 A]/Poly/Ox /Si {t1, t2} is selected in the Film library. You can vary each parameter 1-99 times (i.e., in 1-99 sections of the minimum-maximum range) limited only by the available memory. If there is not enough memory available, the appropriate message appears. If you increase the number of times to vary each parameter, the system requires more time to perform the calculation.

Figure 3.93 Advanced Film Setup window



Cycle selection layer:This parameter is view only (not editable) at the Engineer level.

Cycle selection is a calculation feature that determines the thickness range for a film layer. It is very useful when applied to the layer that is the least known. This operation can be performed on either the first or second film layer. When a System Expert or higher level user selects the *Cycle selection layer* field, a pop-up menu appears with either two or three options: *None* and *Layer 1* for a 1 layer film or a 2 layer film when the bottom film thickness is known (not calculated), *None*, *Layer 1*, and *Layer 2* for a 2 layer film when the thickness of the two layers are measured, and *None*, *Layer 1*, and *Layer 2* for a 3 layer film when the thickness of the first(top) and second(middle) layers are measured. In the example in Figure 3.93, the system performs cycle selection on the poly Si layer (Layer 2), and you can specify the number of times to vary each of the additional measured parameters in the *Layer 1Thickness* and *Layer 2 Ex coef* fields. If *None* is selected in the *Cycle selection layer* field, the system does not perform cycle selection and you can specify the number of times to vary all of the measured parameters.

Number of times to vary each parameter :Specifies how the calculation searches between the minimum and maximum values in the Film parameters

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window. The routine uses the specified number of times (n) to vary each parameter to divide the minimum - maximum range in equal n size trial ranges. The system searches for the best fit independently in each trial range and the measurement results correspond to the best overall fit. Although the calculation takes longer for n>1 than for n=1, this procedure obtains the best nominal values for multi-layer films.

Additional details on using the Advanced film setup window are covered in Therma-Wave's advanced applications course.

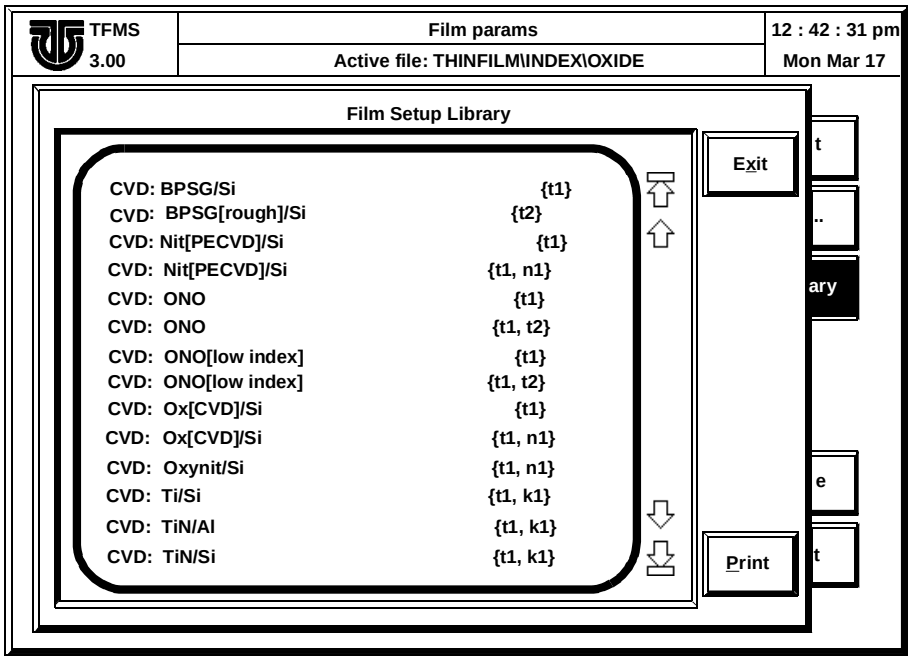
Library button

When you select the *Setup*/*Recipe*/*Film*/*Library* button, the Film Setup Library window appears, as shown in Figure 3.94. This window contains a list of TWI defined standard film stacks and measurement parameters, displayed by process type and film type in alphabetical order.

In addition to the TWI defined film stacks, you can define a personal film stack (user-defined) by modifying the parameters in one of these standard film stacks and saving the changes. At the end of the TWI defined film stack list, if any user-defined film recipes are saved, they appear in alphabetical order with default names or personal names. When you save a personal film stack, the system enters a default name by film, parameters to be measured, date, and time, as shown later in this section. You can replace this default entry with a personal name using the Edit function in the Film Library Maintenance window, described later in this section.

You can scroll through the entire list of films using the scrolling arrows at the right side of the window. For instructions on using the scrolling arrows, see "Scrollable list windows" in your "Getting Started" manual.

Figure 3.94 Film Setup Library window (TWI defined standard film stacks)



A complete list of all the standard film stacks in the Film Library appears in Appendix B.

Each standard entry in the Film Setup Library window includes an abbreviated description of the film stack. In some cases this includes restrictions on one of the film thicknesses. For example, there are separate calculation recipes for Poly/Ox/Si and

Poly/Thin Ox/Si. In addition, each entry displays the parameters to be measured in curly brackets, e.g., {t1, n1} is the thickness and index of refraction of the top film layer.

You select a film stack the same way you select an entry in any other list. When you select a film stack, the Film parameters window reappears with all of the appropriate entries in their respective fields. The name of the film stack and the parameters to be measured appear in the Status line, as shown in Figure 3.94. In addition, the system automatically enters the appropriate parameters in the Fit parameters window, Spatial averaging parameters window, Correlation parameters window, and several System Expert level windows, including the

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Advanced film setup window and the Advanced Calculations parameters window. These parameters are part of the film recipe because they can vary among film stacks. For additional information on the Advanced parameters, see Section 6, "System Expert Functions." At the Engineer level, you can change some, but not all of the film parameters. If you change any of the default parameters, the film stack setup is no longer a standard configuration and its name changes to User-defined film setup.

Save button

The *Save* button in the Film parameters window performs some additional functions. In this window, when you select a film stack using the *Library* button, the system automatically enters parameters in several other windows, as described above. When you select the *Save* button, the parameters in the same windows are saved to the hard disk if you have change privileges for the active job file.

Saving a user defined film: If you select the *Save* button after changing a standard film stack's parameters, a confirmation dialog box appears asking if you want to save your changes. If you confirm your changes, a Status line message says: *Searching for matching film library entry.* If an identical film setup is already saved in the library, the system opens that film setup and displays its name in the Status line. If the same configuration is not saved, another Status line message says*: Creating new film library entry*, and then its default name appears in the Status line (by film name, parameters to be measured, date, and time). This new entry appears in the film library in alphabetical order with any other user-defined films, following the list of standard film stacks. Currently, if you change only the spatial averaging parameters, the system does not create a new entry. You can modify a default entry and enter a personal name by using the *Edit* function in the Film Library Maintenance window (*Setup*/*Library*/*Film*), described later in this section. After you save your new film setup, its name appears in the Status line each time you open the job file's Film parameters window.

AutoLD button

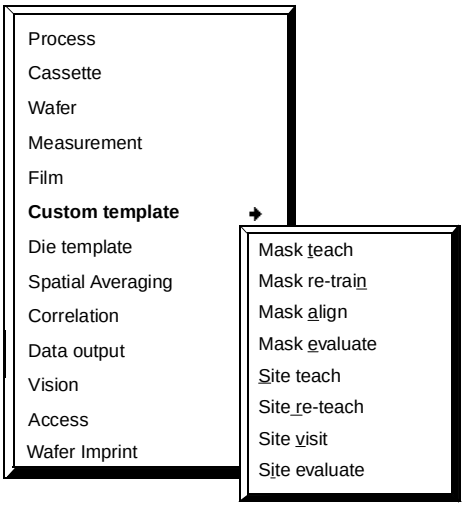
This button operates identically for the Film library and related Film setup parameters as the *AutoLD* button in the Measurement Setup parameters window, described earlier in this section. If autoloading is enabled, all the film parameters are non-selectable.

3.7.7 Custom template

You create a custom template by designating a pattern of measurement points. After creating your job file's custom template, you can add it to the Custom template library so it is accessible to other users who can copy it into their job files. For a description of the Custom template library functions, see *Setup*/*Library*/*Custom Template*, later in this section. In addition, you can copy another user's library custom template into your job file using the above library functions or the *Library* button in the Measurement setup parameters window, described earlier in this section.

When you select *Setup*/*Recipe*/*Custom template* , the Custom template menu appears, as shown in Figure 3.95.

Figure 3.95 Custom template menu (VP installed)



This menu provides eight options used with custom template measurements. Some of these options are applicable for patterned wafers only (*Mask teach*, *Mask re-train*, *Mask align*, *Mask evaluate*, and *Site evaluate*). To use these pattern recognition functions, your system must have a VP installed. For a description of these VP related functions, see Section 4, "Pattern Recognition Functions." If the system you're using doesn't have a VP, these options appear in blue and are non-selectable. This section describes the functions that you'll apply to non-patterned wafers, which do not require a VP.

To access the options in the Custom template menu, you must open a job file, select custom template as the measurement type, and load a wafer on the

measurement stage (loading a wafer is not necessary for the *Site teach* option). If you select any of the Custom template menu options before these conditions are in place, a dialog box appears with a reminder message. If you see this message, select *Ok* and follow the directions in the dialog box before you re-select the desired option.

Mask teach, Mask re-train, Mask align, Mask evaluate (VP systems only)

You can only use these options on patterned wafers if your system has a VP installed. These options allow you to teach, re-train, and save a mask model, accurately align a wafer relative to the mask geometry, and evaluate a pattern as a potential alignment model. For a complete description of each of these operations, see Section 4, "Pattern Recognition Functions."

Site teach

To access this function, you must open a job file and select *Template* as the measurement type and *Custom* as the template type in the Measurement setup parameters window (discussed earlier in this section). If you select *Site teach* before making these selections, a message appears advising you to re-configure these parameters.

When you select *Site teach* in the Template menu, the Teach Measurement Sites window appears, as shown in the example in Figure 3.96. In this window, you define the site coordinates for a custom template, which you can use with or without a pattern recognition vision system. If your system has a VP, you can also set up site by site alignment, as described in Section 4, "Pattern Recognition Functions."

If you open this window with a custom template already saved in the job file, it looks similar to the example shown in Figure 3.96. In this example, a site list appears at the upper right side of the window listing the measurement site numbers and their X/Y coordinates. You use the scrolling arrows on the right side of the list to scroll through the list when there are more than five measurement sites. When you open the window for the first time (before creating a custom template), the list only displays Site 001 without X/Y coordinates.

A Stage locator appears at the bottom of the window with site numbers displayed on the wafer shape. These are the same site numbers displayed in the Site list, and they always reflect the most recent changes you make to your custom template. When you open this window for the first time, the wafer shape is blank. Like any Stage locator, you can use the scroll bars and buttons to move the stages in die size units (set up in the Wafer control parameters window). If a wafer is not loaded, the

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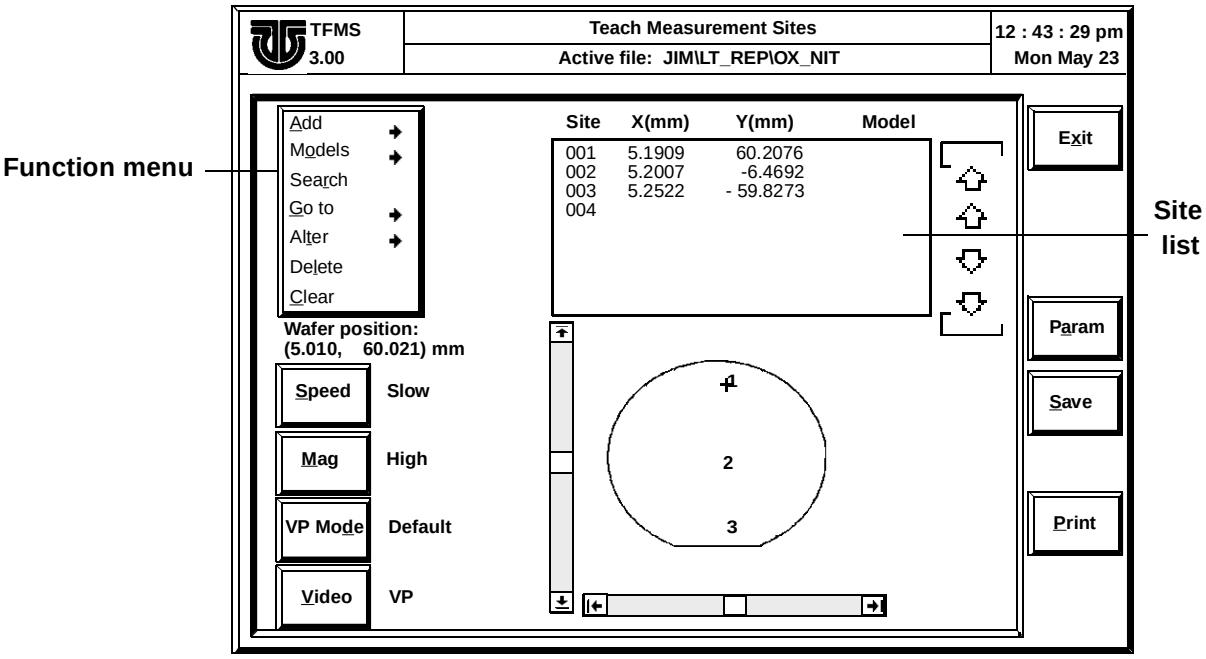
Stage locator is non-functional, the scroll bars and buttons do not appear, and the message *No wafer loaded* appears below the wafer shape. In addition, this Stage locator includes an extra button, *VP mode*, and you see a *Param* button in the window's right margin. These buttons require a VP and are non-functional for systems without a VP. For a description of the *VP* and *Param* buttons, see Section 4, "Pattern Recognition Functions."

At the upper left side of the window you see a Function menu with a list of operations you can perform on the list of measurement sites. If a wafer is not loaded, the *Models*, *Search*, *Go to*, and *Clear* options are non-selectable. For systems without a VP, the *Models* option is always non-selectable, while *Search* is the same as *Go to*. For a complete description of the VP related options, see Section 4, "Pattern Recognition Functions."

Figure 3.96 Teach Measurement Sites window



Video button: Provides three video display options for the sample viewing monitor: *Live* (color), *VP* (Black and White with video box and crosshair), and *Meas area* (Black and White with the spatial averaging and spectrometer regions outlined). The *Meas area* option displays the measurement area on the wafer augmented 2.5µm in each direction based on spatial averaging parameters, and scales the measurement area to the magnification. In addition, this function also displays the spot size area for spectrometer measurements (12µm). The *VP* option

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is non-functional for systems without a VP. For a description of the *Video* button's VP functions, see Section 4, "Pattern Recognition Functions."

Function menu: You can perform the following operations using the Function menu:

Add/Stage X/Y: You can add a measurement site to your custom template by selecting the X,Y coordinates with the trackball or by entering the X,Y coordinates manually.

To select a site using the trackball a wafer must be loaded.

You can use the trackball to add a measurement site to your custom template by following these steps:

1. Position a measurement site under the laser spot with the trackball.

   The sample viewing monitor displays the area near your measurement site.

2. Select a site number in the Site list with the light pen.

   Your selection turns dark green.

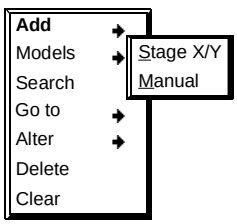
   When the list contains one or more sites, you can select either the empty site (last site number with no coordinates) or one of the existing sites. If there are no sites in the list, select 001.

   If you'd like to select the empty site, and the current list contains five or more sites, use the scrolling arrows to scroll to the empty site at the end of the list.

3. Select *Add* in the Function menu.

   The Add menu appears with two options, *Stage X/Y* and *Manual*, as shown in Figure 3.97.

Figure 3.97 Add menu



4. Select *Stage X/Y* in the Add menu.

5. The new site appears in the list with the number you selected. You see the current stage location displayed next to the site number. The site you selected, and each site listed after it, are re-numbered. This allows you to insert a site between two existing sites in the list.

   If you selected the empty site, a new empty site appears after it. Your new site also appears on the Stage locator's wafer shape.

   The system measures the sites in numerical order.

Add/Manual:If a wafer is not loaded, you must add a measurement site manually. You can add a measurement site to your custom template by manually entering the X, Y coordinates as follows:

1. Select a site number in the Site list with the light pen.

   Your selection turns dark green.

   When the list contains one or more sites, you can select either the empty site (with no coordinates) or one of the existing sites. If there are no sites in the list, select 001.

   If you'd like to select the empty site, and the current list contains five or more sites, use the scrolling arrows to scroll to the empty site at the end of the list.

2. Select *Add* in the Function menu.

   The Add menu appears with two options, *Stage X/Y* and *Manual*, as shown in Figure 3.97.

3. Select *Manual* in the Add menu.

   A dialog box appears where you can enter the X,Y coordinates, as shown in Figure 3.98

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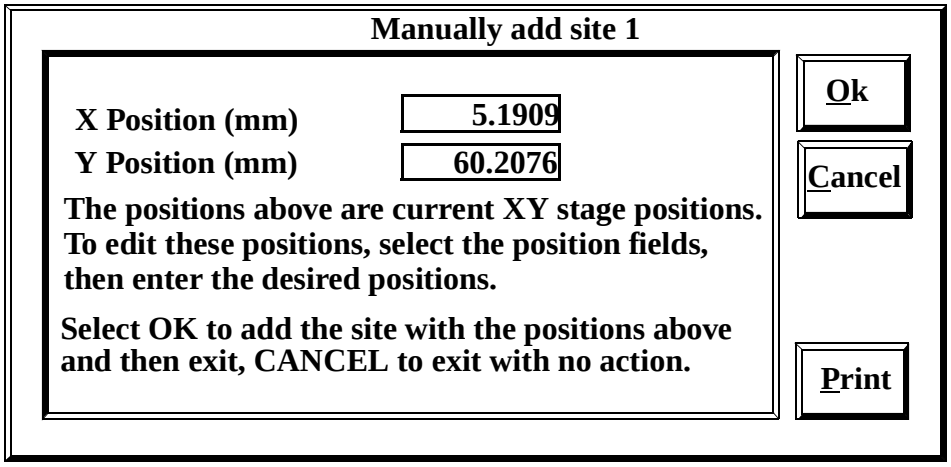
Figure 3.98 Site entry dialog box


Manually add site 1
X Position (mm)
5.1909
Y Position (mm)
60.2076
The positions above are current XY stage positions. To edit these positions, select the position fields, then enter the desired positions.
Select OK to add the site with the positions above and then exit, CANCEL to exit with no action.
Ok
Cancel
Print

4. Enter the X,Y coordinates and select *Ok* in the dialog box.

   The new site appears in the list with the number you selected. You see the current stage location displayed next to the site number. The site you selected, and each site listed after it, are re-numbered. This allows you to insert a site between two existing sites in the list.

   If you selected the empty site, a new empty site appears after it. Your new site also appears on the wafer shape.

***Models* (VP systems only):** This option allows you to save a digitized representation of a feature (model) located on a patterned wafer. It requires a VP and is non-selectable for systems without a VP. For a complete description of the *Models* option, see Section 4, "Pattern Recognition Functions."

***Search* (VP systems only):** This option allows you to search the field of view for a feature that matches a previously saved model. It requires a VP and doesn't perform any function for systems without a VP. For a complete description of the *Search* option, see Section 4, "Pattern Recognition Functions."

Go to : You can drive the stages to a site by following these steps:

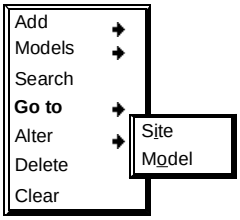
1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The Go to menu appears with two options, *Site* and *Model*, as shown in Figure 3.99.The *Model* option requires a VP and is non-selectable for systems without a VP. For a complete description of the *Model* option, see Section 4, "Pattern Recognition Functions."

Figure 3.99 Go to menu



3. Select *Site* in the Go to menu.

   The stages go to the selected site location. The screen blanks briefly while the stages are moving.

   The sample viewing monitor displays the area near your measurement site.

Alter :You can alter a custom template measurement site by selecting the new X,Y coordinates with the trackball or by entering the new X,Y coordinates manually.

To alter a site with the trackball, a wafer must be loaded, and there should be no model associated with the site.

You can use the trackball to alter a custom template measurement site by following these steps:

1. Select a site in the Site list with the light pen.

   Your selection turns dark green.

2. Position a measurement site under the laser spot using the trackball.

   The sample viewing monitor displays the area near your measurement site.

3. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*. This menu looks the same as the Add menu shown in Figure 3.97. You follow the same steps to Alter an existing site as you do for adding a new site.

4. Select *Stage X/Y* in the Alter menu.

   The new X/Y coordinates appear next to your selected site in the Site list, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Delete: You can remove a site from a custom template by following these steps:

1. Select a site in the Site list.
2. Select *Delete* in the Function menu.

   A confirmation dialog box appears.

3. Select *Ok* in the dialog box to delete the site.

   The site you selected disappears from both the Site list and the wafer shape. Any sites listed after it are re-numbered.

Clear: You can remove all the sites from a custom template by following these steps:

1. Select *Clear* in the Function menu.

   A confirmation dialog box appears.

2. Select *Ok* in the dialog box to delete all the sites from the template.

   All sites disappear from both the Site list and the wafer shape.

Site re-teach

Occasionally, you may want to re-teach the template measurement sites after re-teaching mask alignment on systems with a VP. You can also perform this function with non-VP systems on both patterned and unpatterned wafers. If you

want to re-teach sites on patterned wafers and your system does not have a VP, you should perform your measurement on areas with large patterns.

Typically, you'll want to shift the template sites by an X/Y translation and/or a theta rotation to correct their locations. The re-teach function allows you to adjust an entire template by re-teaching only 3 sites.

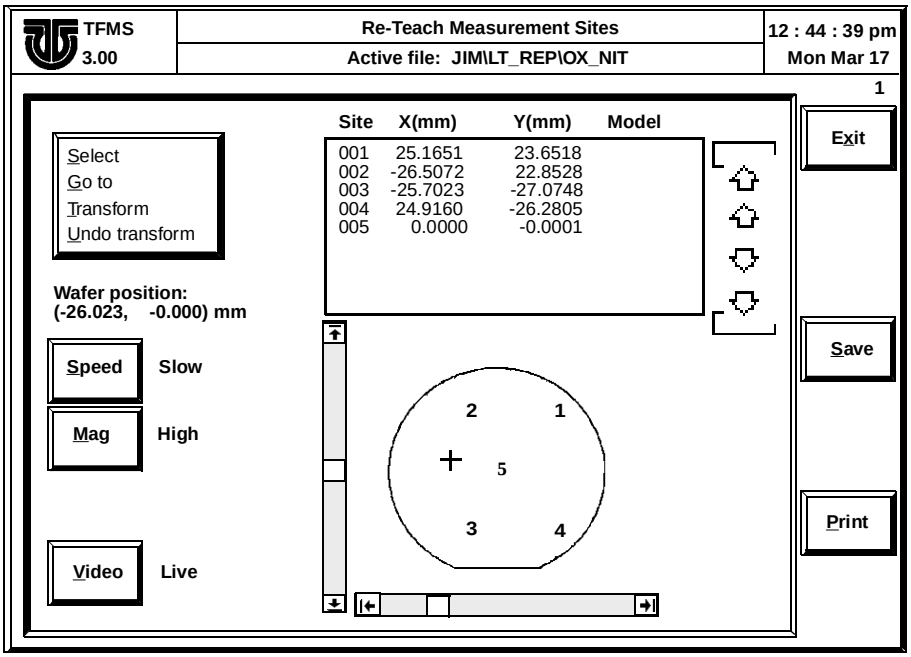
If your custom template contains only one or two sites, or if only some of the sites require modification, use the *Alter* function in the Teach Measurement Sites window (Site teach operation) instead of the re-teach function.

To use *Site re-teach*, you must open a job file, load a wafer on the measurement stage, and select custom template as the measurement type. In addition, your custom template must contain measurement sites previously set up in the Teach Measurement Sites window. If you select *Site re-teach* before these conditions are in place, a dialog box appears with a message reminding you what to do.

To effectively use this function, you must know the correct measurement site locations.

When you select *Setup*/*Recipe*/ *Custom template*/*Site re-teach*, the Re-teach Measurement Sites window appears, as shown in Figure 3.100. You see a Stage locator at the bottom, a Site list at the upper right side, and a Function menu in the upper left corner. For step-by-step instructions, see the "Using the Site re-teach function" tutorial in your "Getting Started" manual.

Figure 3.100 Re-teach Measurement Sites window



Stage locator: The Stage locator is similar to the one in the Teach Measurement Sites window.

Site list: The Site list displays the measurement site numbers and their X,Y coordinates. You use the scrolling arrows to scroll through the list when there are more than five measurement sites.

Function menu: The Function menu displays a list of functions you can perform within the re-teach operation.

> ***Select:*** You use the *Select* function (along with the *Go to* function) to select one of the 3 sites to re-teach. You should perform the *Go to* and *Select* operations on 3 sites that are far apart from each other, and then use the transform function (described later).
>
> You can select a site by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The stages go to the listed site coordinates. The screen blanks briefly while the stages move.

   The sample viewing monitor displays the area near the site.

3. Use the trackball to move to the correct measurement site location.

   You can toggle between high and low magnification by selecting the *Mag* button. For optimum placement, make your final adjustment in high magnification.

4. Select *Select* in the Function menu.

   The site number in the wafer shape changes from black to red, which identifies the selected site. The system remembers the current X, Y stage coordinates, which become the new coordinates for this site after you perform a transformation. See *Transform*, later in this section.

   If you select three sites and attempt to select a fourth, a message tells you that additional re-teach sites are not selectable.

You can undo a site designation by following these steps:

1. Select a previously selected site in the Site list, which has a corresponding red site number in the wafer shape.

   Your selection turns dark green in the Site list.

2. Select *Select* in the Function menu.

   A dialog box appears informing you that the re-teach selection is canceled.

3. Select *Ok* in the dialog box.

   The site number in the wafer shape changes from red to black indicating that the site was returned to its original condition.

Go to: You can drive the stages to a specific measurement site location by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

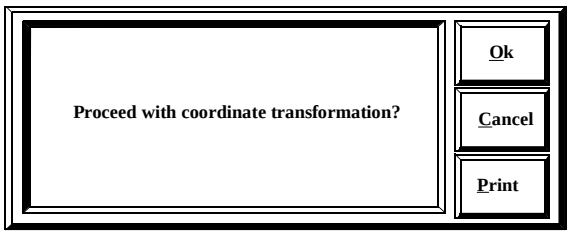
   The stages go to the listed site coordinates. The screen blanks briefly while the stages move. The sample viewing monitor displays the area near the site.

Transform: You use this function after selecting 3 sites. You can transform your template by following these steps:

1. Select *Transform* in the Function menu.

   If you selected 3 sites, a dialog box appears, as shown in Figure 3.101.

Figure 3.101 Transform dialog box



   If you selected fewer than 3 sites, a dialog box appears reminding you that 3 sites must be selected.

2. Select *Ok* in the dialog box.

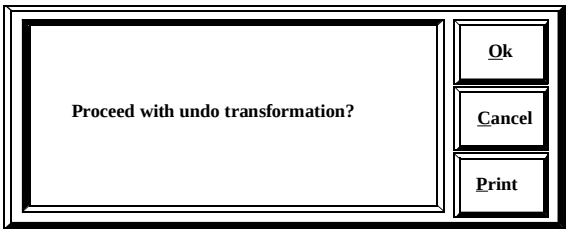
   The system calculates the X, Y, and theta offset between the old and new coordinates for the three selected sites and applies this offset to all the sites in the template. The Site list displays the new X,Y coordinates for all the sites.

Undo transform: You use this function to undo the most recent transformation performed in the active job file and restore the template to its previous state. You can perform an *Undo transform* operation any time after a *Transform* operation. You do not have to perform this operation before exiting the window or closing the job file. If you're not satisfied with the new (transformed) site locations, you can undo the most recent transformation by following these steps:

1. Select *Undo transform* in the Function menu.

   A dialog box appears, as shown in Figure 3.102

Figure 3.102 Undo transform dialog box



   If you didn't perform a transformation, or if you try to undo a second time, a dialog box appears informing you that the undo operation is not possible.

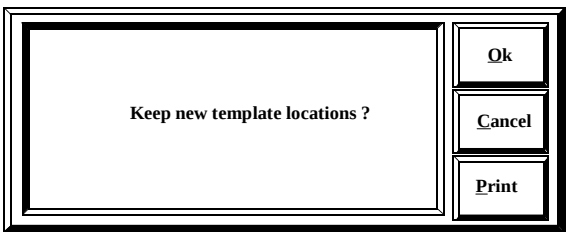
2. Select *Ok* in the dialog box.

   The system subtracts the X,Y and theta offset applied during the previous *Transform* operation, and restores the original site locations. The Site list displays the original X,Y coordinates.

   At this point, you have the option to de-select one or more of the 3 selected sites, select new sites, and perform another transformation.

:Exit button: Closes the window. When you select the *Exit* button after performing a Transform operation without selecting the *Save* button, a dialog box appears, as shown in Figure 3.103.

Figure 3.103 New template dialog box



Select *Ok* to retain the new site locations. If you select *Cancel*, it is the same as performing an *Undo transform* operation. In either case, you return to the Template menu.

When you select the *Exit* button after performing an Undo transform operation without selecting the *Save* button, the dialog box in Figure 102 appears. In this case, select *Ok* to retain the *Undo transform* operation or *Cancel* to cancel it (and restore the original transformation).

Because the Site re-teach function applies the same offset to all ofthe template sites, make sure you select 3 sites that have aconsistent offset relative to the desired location.

In addition, because the Site re-teach function is designed for templates that cover a fairly large area, if your template is smaller than a few centimeters, unsatisfactory results can occur.

After performing a transform, use the Site visit function to see if the transformed coordinates are satisfactory. If they are not, undo the transform and re-teach your site locations in theTeach Measurement Sites window (Site teach function).

Site visit

To use this function, you must open a job file, load a wafer on the measurement stage, and select custom template as the measurement type. In addition, your custom template must contain measurement sites previously set up in the Teach Measurement Sites window. This function verifies the location of all your custom template measurement sites. When you select *Setup*/*Recipe*/*Custom Template*/*Site visit*, a dialog box appears that says: *Visit sites in both High and Low magnifications?* You select *Yes* to visit sites in both high and low magnifications or *No* to visit sites in high magnification only. After making your selection, the stages move to each site in numerical order, as displayed on the sample viewing monitor in the specified magnification(s). During this operation, the Site visit window appears on the TFMS monitor, depicting each measurement site as a numbered box on a wafer shape. Each numbered box turns light purple momentarily as the stages pause, then dark purple as the stages move to the next site. A *Halt* button appears in the window's right margin.

Halt button:Halts the *Site visit* operation. When you select the *Halt* button, after the system visits the current site, a dialog box appears that says: *Continue visiting sites?* Select *Cancel* to cancel the *Site visit* operation or *Ok* to continue.

Site evaluate (VP Models only)

Setup/*Recipe*/*Custom Template*/*Site evaluate* requires a VP and is applicable for patterned wafers. It allows you to evaluate wafer features as site alignment targets

and compare wafer images to a saved test model image. You can use this information to diagnose site alignment problems or verify that the saved model is satisfactory. For a complete description of this operation, see Section 4, "Pattern Recognition Functions."

3.7.8 Die template (VP models only)

Setup/*Recipe*/*Die Template* requires a VP and is applicable for patterned wafers. It allows you to create and use a die template in your job file. For a complete description of this operation, see Section 4, "Pattern Recognition Functions."

3.7.9 Spatial Averaging

The system uses spatial averaging to scan the wafer over a specified area during the data acquisition part of the measurement sequence. This technique provides improved raw data (array profiles, etc.) for films with grain structure, such as polySi, amorphous Si, and metals. In some cases, it also improves measurements of dielectric films.

All Therma-Wave supplied standard film stack recipes contain spatial averaging setups appropriate for their respective film stacks. Except for geometrical considerations, these recipes should require no modification. When you select *Setup*/*Recipe*/*Spatial Avg* , the Spatial averaging parameters window appears, as shown in Figure 3.104 (with spatial averaging disabled). In this window, you can enable or disable spatial averaging and modify the default setup.

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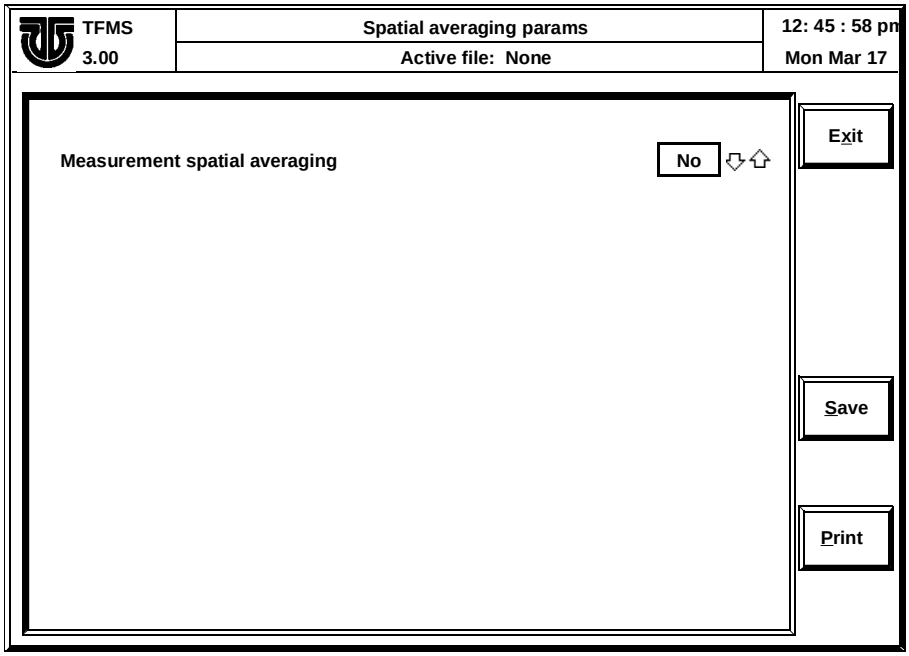
Figure 3.104 Spatial averaging parameters window (spatial averaging disabled)

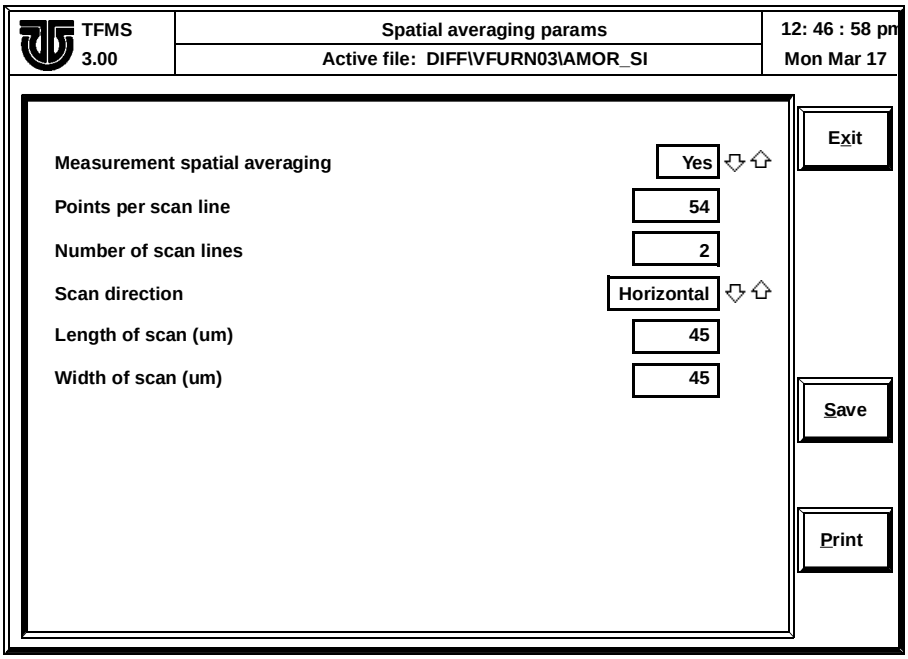


Measurement spatial averaging

Specifies whether spatial averaging is enabled or disabled. If you select *No* to disable it, the window looks like Figure 104. If you select *Yes* to enable it, the default spatial averaging parameters appear, as shown in Figure 105.

In this window, you can modify the size and direction of the scanning area. (spatial averaging enabled)

Figure 3.105 Spatial averaging parameters window (spatial averaging enabled)



Following is a description of the above parameters.

Points per scan line

Specifies the number of points of spatial averaging per scan line. For optimum data acquisition efficiency, use a multiple of 18.

Number of scan lines

Specifies the number of scan lines used for spatial averaging. When you enter a value of 1, the system performs linear spatial averaging. When you enter a value greater than 1, the system performs area spatial averaging, and the scan width should be nonzero.

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Scan direction

Specifies the direction (horizontal or vertical) that the stages move along each line of spatial averaging. If you configure area spatial averaging, a snake pattern is traced out: the stages move in the specified direction for each scan line and in the perpendicular direction between lines.

Length of scan (µm)

Specifies the length, in microns, of each scan line. The optimum spacing between points is ~ 0.8 µm, i.e., slightly less than the diameter of the focused laser spot (e.g., length = 45µm for a 54 point line).

Width of scan (µm)

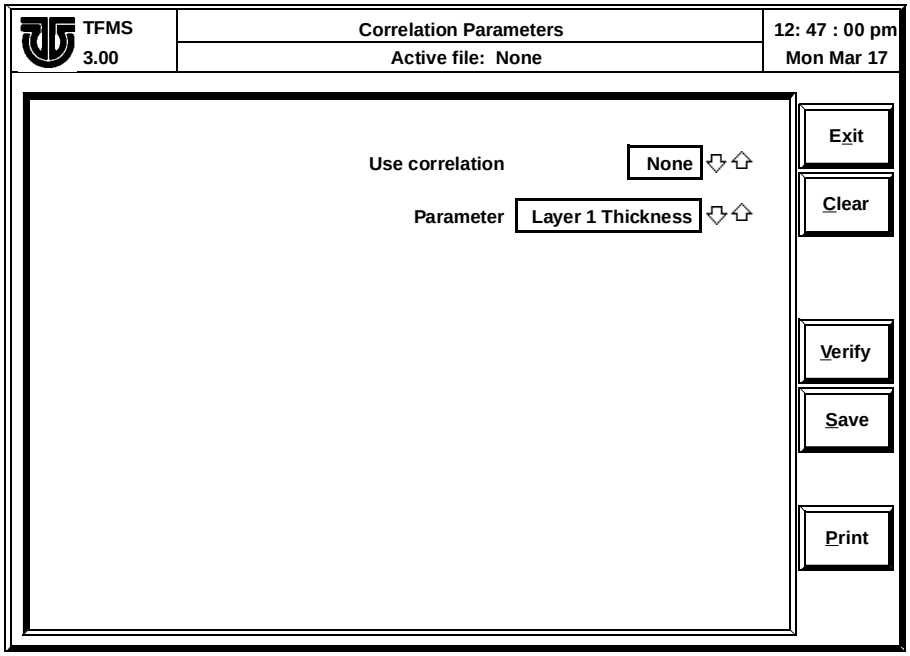
Specifies the width, in microns, of the spatial averaging area. If the number of scan lines is 1, this parameter is ignored. If the number of scan lines is greater than 1, the spacing between lines equals the scan width divided by (n-1), where n is the number of scan lines.

You should only change the default scan length and width for geometric reasons, e.g., the size and/or shape of the measurement area on a patterned wafer. You should avoid specifying a width of 0 if the number of scan lines is greater than 1. For more information on this parameter, see "Configuring spatial averaging for a small measurement area" in your "Getting Started" manual.

3.7.10 Correlation

When you select *Setup*/*Recipe*/*Correlation* , the Correlation parameters window appears, as shown in Figure 3.106. You use this function to correlate the measurements of an Opti-Probe system with measurements from any other system, e. g., another Opti-Probe or some other thickness measurement tool. The Opti-Probe applies the correlation to the desired measurement parameter (e.g. Layer 1 Thickness). When you specify a correlation, SPC plots, measurement displays, and printouts use the correlated data. The system saves the correlation data with a job file's database measurement records and copies this information during Data to floppy and SECS transfers.

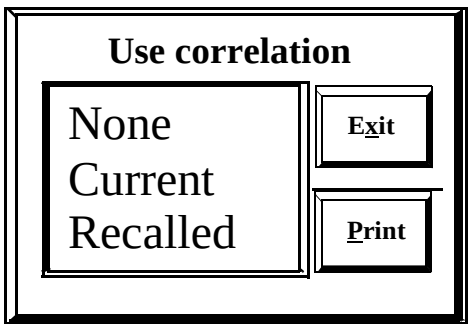
Figure 3.106 Correlation Parameters window (correlation disabled)



Use correlation

When you select this field, three options appear, as shown in Figure 3.107.

Figure 3.107 Use correlation pop-up menu

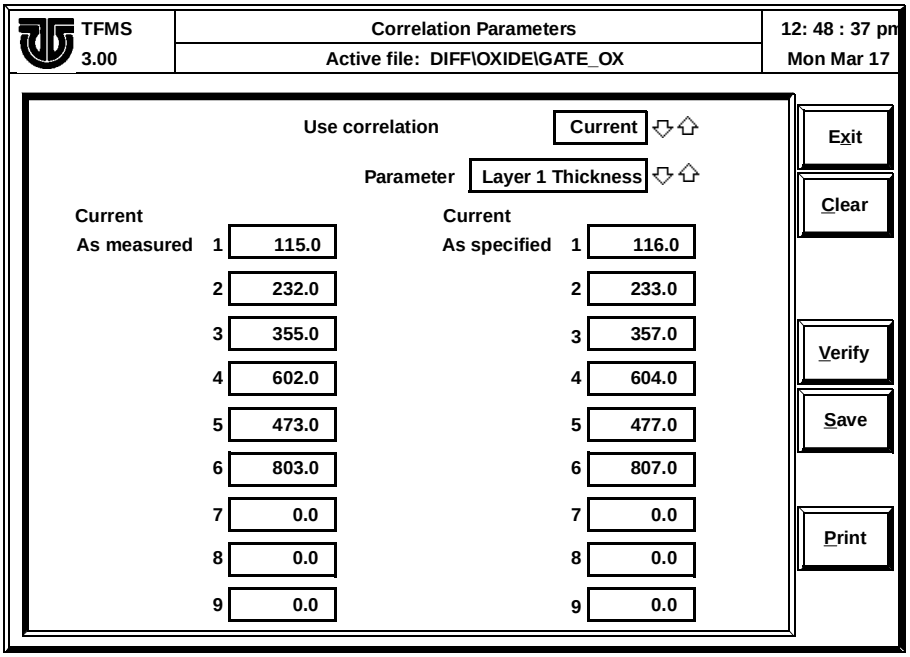


None: When you select *None* in the *Use Correlation* field correlation is disabled, and the Correlation parameters window looks like Figure 3.106.

Current: This option specifies correlated measurement results using the values you enter in this window. When you select *Current* in the *Use correlation* field, a set of

As measured values and a corresponding set of As specified (desired) values appears, as shown in the example in Figure 3.108. The *As measured* fields represent film thickness measurements made on different films, using the same Opti-Probe. The corresponding values in the *As specified* fields specify those values you want the Opti-Probe to report. You specify the correlation by entering the desired values in these fields.

Figure 3.108 Correlation Parameters window (correlation enabled)



As measured, As specified: When you select any of the *As measured* and *As specified* fields, a calculator window appears where you enter the desired value.

For the example in Figure 3.108, if the Opti-Probe measures 115 Å, it reports 116 Å. The entries in this window should span the entire range of values used by the job file. The correlation function extrapolates outside this range, but the extrapolation may not be accurate. If you perform a measurement that is outside the range entered in this window, a dialog box appears that says: *WARNING - Bad correlation. m out of n points were out of range. An extrapolation has been performed.* m and n values are filled in. After you select *Ok* to close the dialog box, your measurement results appear.

When you enter pairs of values in the Correlation Parameters window, it isn't necessary to make entries in all the fields or enter the values in any particular order. When you select the *Save* button, a message appears that says: *Do you want to save your changes?* Select *Ok* to save your entries, or *Cancel* to return to the window without saving.

If you'd like to use a simple offset (e.g., subtract 1 Å), you can enter a single pair of correlation values, e.g., As measured, enter 100, As specified, enter 99. If you only enter 1 pair of values, they are treated as an offset.

Recalled :Specifies correlated measurement results using As measured values and As specified values recalled from correlated saved measurements. If the current correlation values were changed after the measurements were saved or if measurement records were transferred from another system, the recalled correlation values can differ from the current correlation values. Measurement records that were saved using earlier versions of TFMS do not contain correlated data and always use the current correlation values.

To display a recalled correlated measurement, you select *Main menu*/*Display Saved measurement*, and select a database record with correlated saved data. When the Measurement results window appears, it indicates that the measurement record includes correlated data. In the Measurement results window, you can temporarily override the correlation setup by selecting the *Param* and *Corr* buttons (single point measurements - select only *Corr*) to display the Correlation Parameters window, where you can toggle between a current and recalled correlation display. To display a correlated single point measurement or a correlated SPC plot, see Section 3, "Operation Summary."

After you specify a recalled correlation, the current correlation setup is still displayed in the Correlation Parameters window. The system recalls the As measured and As specified values for the correlation, but does not display these values.

Parameter

In this field, you can select a measurement parameter to use for the correlation (e.g., Layer 1 Thickness). All thicknesses in this window are in Angstroms (Å)

Verify button

When you select the *Verify* button, the Correlation Function window plots the current *As measured* and *As specified* values for the selected parameter. The

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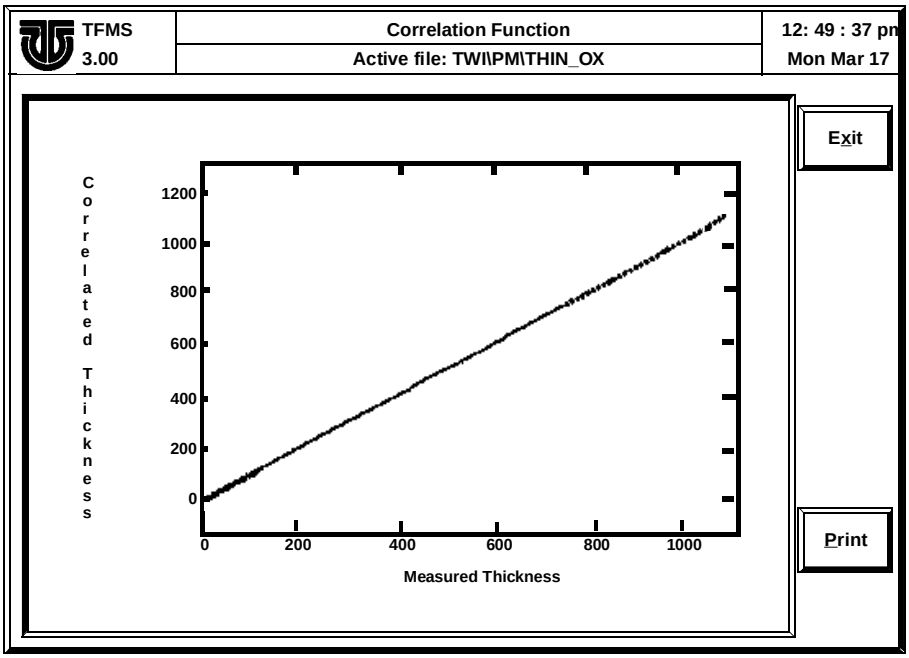
example in Figure 3.109 shows a typical thickness correlation plot generated from the current values entered in Figure 3.108. The system always generates the plot using the currently displayed *As measured* and *As specified* values.

The system plots the *As measured* values on the horizontal axis and the *As specified* or correlated values on the vertical axis. The solid green curve represents the range of values in the table, while the red symbols represent nearby extrapolated values. The system applies the correlation mathematically as a cubic spline fit to interpolate between values in the table and extrapolate from them

Figure 3.109 Correlation Function window (correlated film thickness)



When you select the *Verify* button, the system sorts the values in order and verifies that they are monotonic. If your correlation function is not monotonic, an error message appears saying: *Correlation function is not monotonic.* Select *Ok* to close the error message box and correct the values in the Correlation parameters window before performing a measurement. If you perform a measurement and the correlation function is not monotonic, the same error message appears in place of your measurement results.

When you select the *Verify* button and all the As measured entries are zero, a dialog box appears that says: *0 points - No correlation will be done.* You select *Ok*

to close the dialog box and enter appropriate values in the *As measured* and *As specified* fields.

If you set up correlation parameters for a simple offset (e.g., subtract 1 Å) and then select the *Verify* button, a message appears saying: *Measured values of thickness will be offset by a constant value of -1.0 (A)*. This message appears instead of the Correlation Function window. Select *Ok* to close the dialog box and return to the Correlation parameters window.

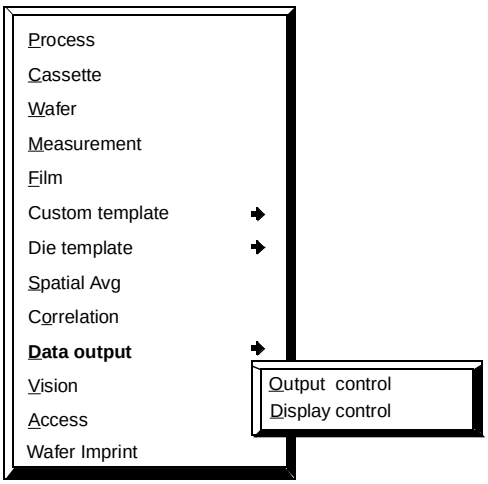
Clear button

When you select the *Clear* button, a dialog box appears saying: *Clear correlation parameters?* Select *Ok* to clear all the entries or *Cancel* to retain the entries.

3.7.11 Data output

When you select *Setup*/*Recipe*/*Data output* , the Data output menu appears, as shown in Figure 3.110. You can specify the data to be displayed or printed, and whether that information is saved, displayed or printed automatically or manually.

Figure 3.110 Data output menu



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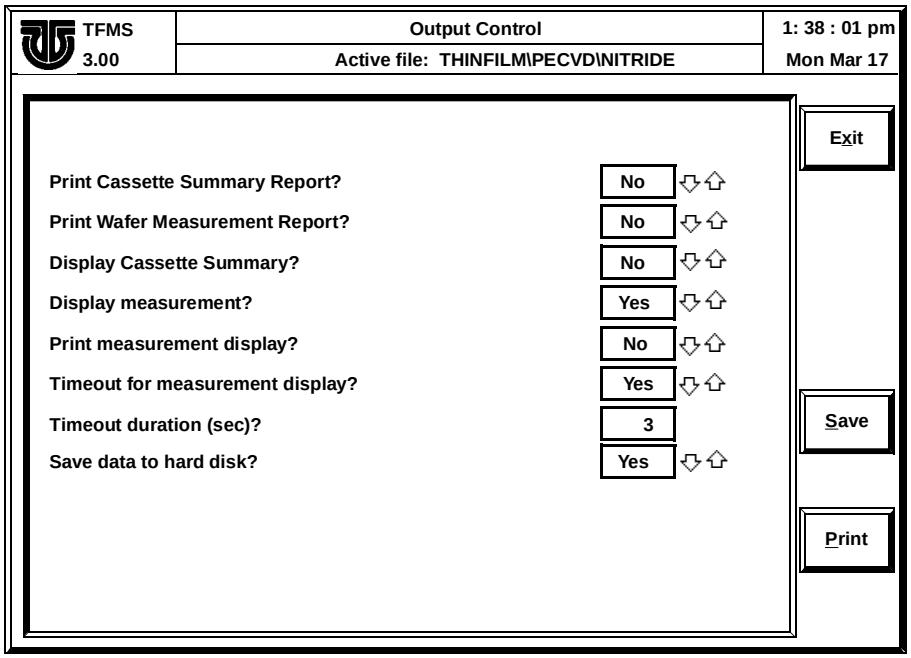
Output control

When you select *Setup*/*Recipe*/*Data output* /*Output control* , the Output Control window appears, as shown in the example in Figure 3.111. In this window, you can enable the automatic printing, saving, display, and display duration of measurement data for the active job file. If you are the owner of the active job file or a System Manager and you enable the saving of data, you can set up some additional parameters, as described later in this section.

Figure 3.111 Output Control window



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Print Cassette Summary Report : Specifies whether or not the system prints a cassette summary report when a cassette measurement is specified in the Cassette information window. If you select *Yes*, the system prints a cassette summary report after measuring all the specified wafers in a cassette. This report is a one-page summary of the cassette measurement that includes header information from the Process Setup and Measurement setup windows, and statistical information for each wafer designated for a measurement. The statistical information includes average +/- sigma for each measured parameter, where sigma is the 1-sigma standard deviation. Figure 3.112 shows an example report. On SMIF Indexer systems, *SOURCE STATION* and *DESTINATION STATION* fields replace the *STATION NUMBER* field. Following these fields, a Table lists the source cassette slots and their corresponding destination.

Figure 3.112 Cassette Summary Report

```
                                        CASSETTE SUMMARY REPORT                                    Page 1
Job file: TRAIN\ALB\CASS                  Optiprobe 2500-6042                                   TFMS 3.00
Owner:    SE1                          Printed: 17-Mar-97 14:00:17

COMMENTS            :

OPERATOR            :                   SHIFT              :
MEASUREMENT DATE    : 17-Mar-97         MEASUREMENT TIME   : 13:58:52        STATION NUMBER     : 1
EQUIPMENT           :
RUN NUMBER          :                   LOT ID             :

MEASUREMENT TYPE    : Line scan
NUMBER OF POINTS    : 5
SCAN DIRECTION      : Horizontal
WAFER DIAMETER (MM) :   150.0000
LINE LENGTH (MM)    :   100.0000
CENTER X (MM)       :     0.0000
CENTER Y (MM)       :     0.0000

LAYER 1 FILM        : Thermal oxide
SUBSTRATE           : Si undoped

-------------------------------------------------------------------------------------------------------------------------------------------

                              Film Thickness (A )
SLOT      WAFER ID        MEAN      SIGMA    % SIGMA
---- -------------------- --------- --------- ---------

  1                        21.36      0.59     2.78
  2                       542.53      5.05     0.93
  7                        15.39      0.23     1.53
                         --------- --------- ---------
    CASSETTE MEAN         193.09      1.96     1.75
-------------------------------------------------------------------------------------------------------------------------------------------
    RANGE                 527.13
    MINIMUM                15.39
    MAXIMUM               542.53
```


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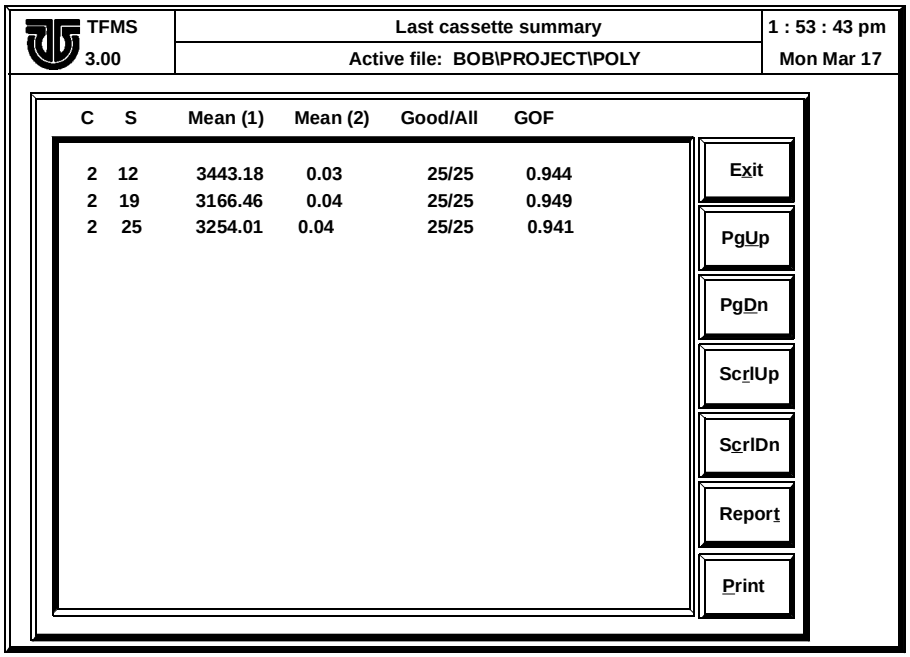
Print Wafer Measurement Report: Specifies whether or not the system prints a Wafer measurement report after each wafer measurement (single point, line scan, etc.). This report is a one-page summary of the wafer measurement and includes header information from the Process Setup and Measurement setup windows, and measurement results for each point/site on the wafer, as shown in the example in Figure 3.113. It is identical to the report generated by the *List* button shown in the Measurement results windows later in this section. The *List* button is described in Section 2, "Operation Summary" and the separate "Getting Started" manual."

Figure 3.113 Wafer Measurement Report

```
                                        WAFER MEASUREMENT REPORT                                  Pag
Job file: TRAIN\ALB\CASS                    Optiprobe 2500-6042                                   TFMS 3
Owner:    SE1                           Printed: 17-Mar-97 13:59:56

COMMENTS            :

OPERATOR            :                   SHIFT              :
MEASUREMENT DATE    : 17-Mar-97         MEASUREMENT TIME   : 13:58:52        STATION NUMBER     : 1
EQUIPMENT           :                   WAFER ID           :                 SLOT               : 7
RUN NUMBER          :                   LOT ID             :

MEASUREMENT TYPE    : Line scan
NUMBER OF POINTS    : 5
SCAN DIRECTION      : Horizontal
WAFER DIAMETER (MM) :   150.0000
LINE LENGTH (MM)    :   100.0000
CENTER X (MM)       :     0.0000
CENTER Y (MM)       :     0.0000

LAYER 1 FILM        : Thermal oxide
SUBSTRATE           : Si undoped

PARAMETER 1         : Film Thickness (A )
MEAN                :     15.39         RANGE              :     0.71
MIN                 :     15.03         STD DEV            :     0.23
MAX                 :     15.74         % STD DEV          :     1.53

-------------------------------------------------------------------------------------------------------------------------------

Point   X (MM)     Y (MM)   Film Thickness (A )   GOF
----- ---------- ---------- ------------------- -------

  1    -50.0000    0.0000         15.03        0.9994
  2    -25.0000    0.0000         15.74        0.9969
  3      0.0000    0.0000         15.30        0.9967
  4     25.0000    0.0000         15.39        0.9966
  5     50.0000    0.0000         15.51        0.9966
```

Display Cassette Summary :Specifies whether or not the system displays a run summary at the end of each cassette measurement (one or two cassettes). When you select *Yes*, a one line description of the measurement results for each wafer appears on the screen with the following information: cassette number, slot number, measurement, average results for all measurement parameters, GOF good points/Total points measured, and average GOF value. Figure 3.114 shows an example run summary. If you select the *Report* button, the system prints a copy of the Cassette summary report.

Figure 3.114 Run summary



Display measurement:Specifies whether or not the system displays a measurement results window at the end of each wafer measurement. If you set up a timeout, the window closes after the indicated time, as explained below under *Timeout for measurement display* and *Timeout duration (sec).* If you disable the display timeout, the measurement results remain on the screen until the operator selects the *Exit* button. For fully automated, unattended measurements, you can either enable the display along with a timeout or disable the display. If you disable the display, the remaining three fields do not appear or function.

Print measurement display:Specifies whether or not the system prints the measurement results window which appears after each wafer measurement. This

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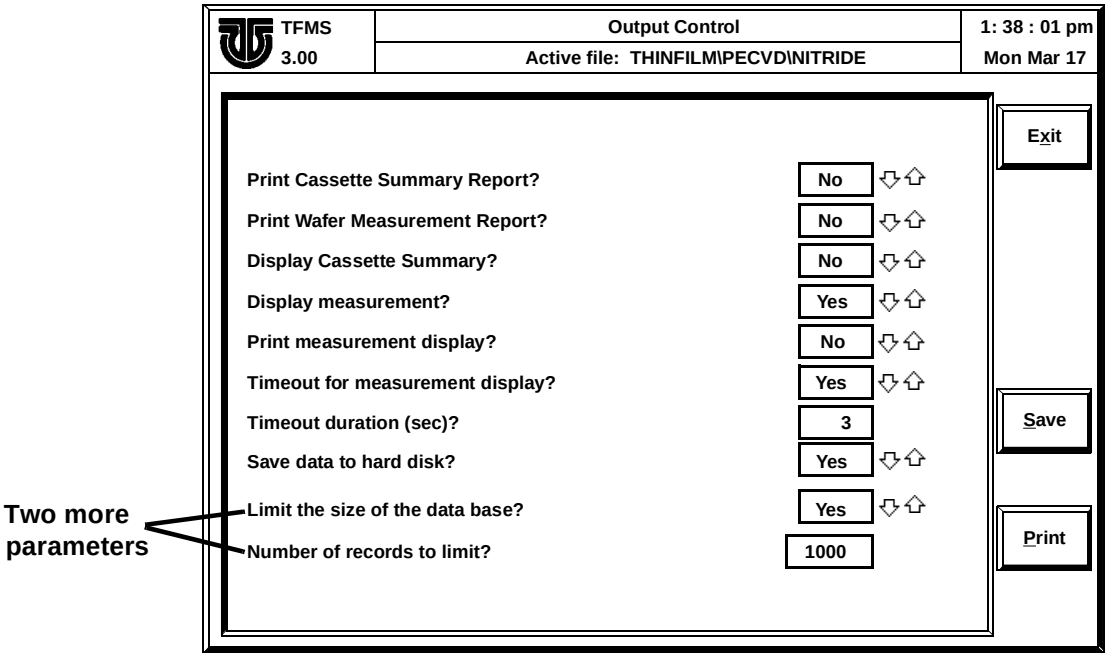
option generates the same printout as the *Print* button in the Measurement results window. This field does not appear or function when *Display measurement* is disabled. For line scan, area scan, and polar map measurements, the system prints the line plot or map. For template measurements, the system prints the tabular results or map. If the template measurement has more than eight points, the system displays and prints only eight points in tabular format.

Timeout for measurement display: Specifies whether or not the measurement results window closes after a specified time interval, when *Display measurement* is enabled. If you select *Yes*, the window closes after the interval entered in the *Timeout duration (sec)* field below. If you select No, it remains on the screen until the operator selects the Exit button. This field does not appear or function when *Display measurement* is disabled.

Timeout duration (sec) : Specifies how long (in seconds) the measurement results window appears when *Display measurement* and *Timeout for measurement display* are enabled. A value of zero is equivalent to selecting no timeout, i.e., the operator must close the results window. This field does not appear or function unless the above two operations are activated.

Save data to hard disk: Specifies automatic saving of measurements. When you select *Yes*, the system automatically saves all measurements to the active job file's database. If you select *No*, the operator must save any measurements that require saving. See "Save" in Section 2, "Operation Summary." For cassette measurements with more than one wafer, if you want to save data, make sure you select *Yes*. If data saving is enabled and you are the owner of the job file or a System Manager, you can set up two additional parameters, as shown in Figure 3.115.

Figure 3.115 Output Control window (Owner/ Sys. Mgr. with data saving and database limit enabled)



Limit the size of the data base :This parameter only appears if data saving is enabled and you are the owner of the job file or a System Manager. It specifies whether to limit the size of the job file's database. When you limit the size of the database and the number of records exceeds that limit, the system deletes the oldest records. If you select *Yes*, an additional parameter appears, *Number of records to limit*, described below.

Number of records to limit :If the database size is restricted, this parameter appears. It specifies the number of records allowed in the job file's database. .

Display control

When you select *Setup*/*Recipe*/*Data output*/*Display control*, the appropriate display parameters window appears for the job file's measurement type and display type.

In this window, you can specify the appearance of measurement results windows (e.g., *Display* /*Last measurement*, *Display* /*Saved Measurement*). Following are descriptions of the display parameters for each of the measurement types except single point, which has only one display parameter, *Display measurement*.

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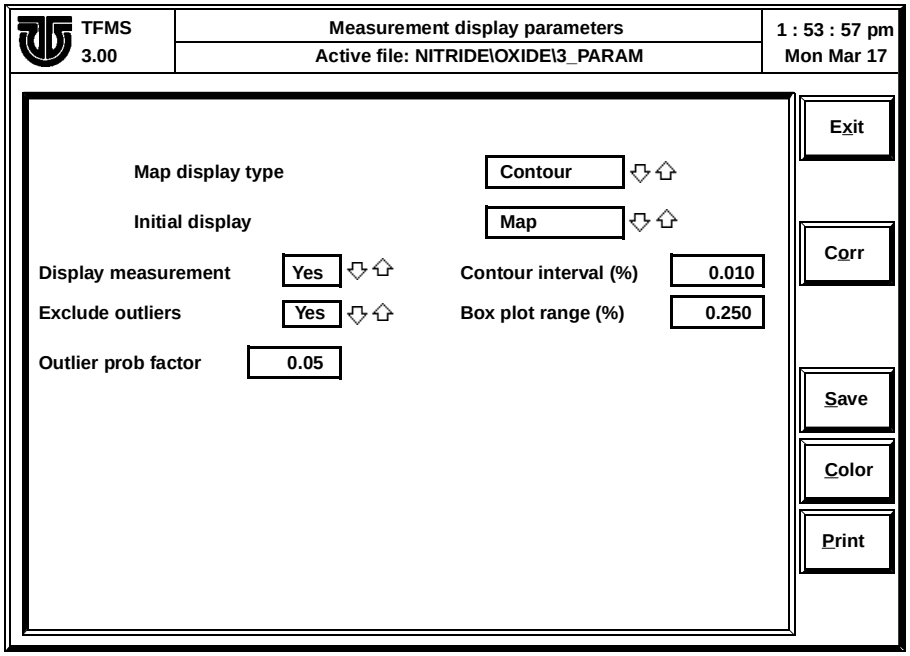
Examples of measurement results windows for each of the measurement types appear in your "Getting Started" manual.

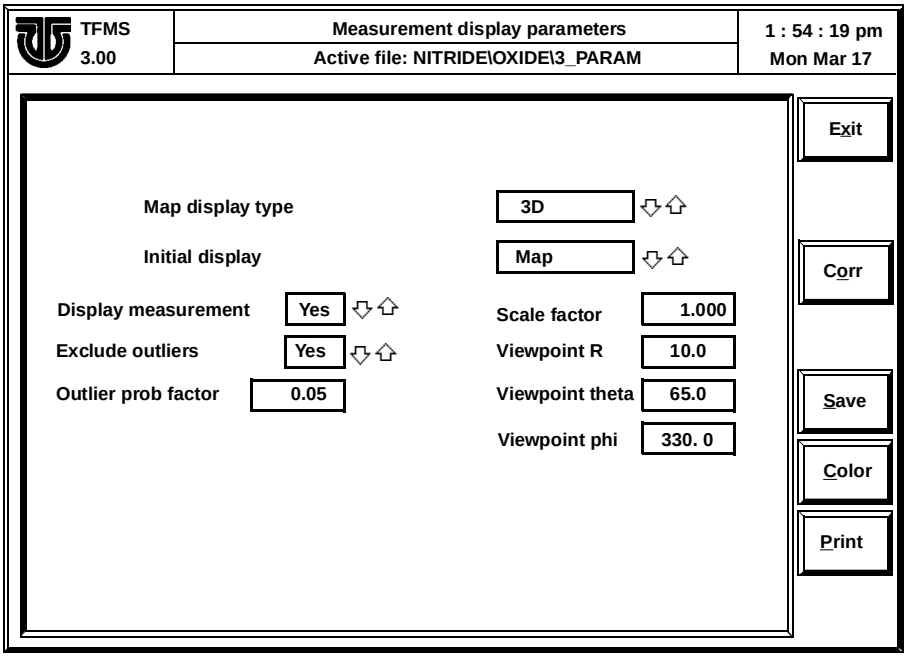
Area scan/Polar map: When your job file is set up for an area scan or polar map contour display, the display parameters window looks similar to the example in Figure 3.116.

Figure 3.116 Area scan or Polar map display parameters window (contour display)



Map Display type: Specifies the type of area scan or polar map display. The options are *Contour* and *3D*. If you select *Contour*, the Area scan or Polar map display parameters window looks like the example in Figure 3.116. If you select *3D*, the Area scan or Polar map display parameters window looks like the example in Figure 3.117.

Figure 3.117 Area scan or Polar map display parameters window (3D display)



A contour map shows a series of curves representing equal values of the selected measurement parameter, as shown in the measurement results window in Figure 3.118 for an area scan.

The +, –, and ▫ symbols represent measurement points. A ▫ symbol indicates that the measured value falls within a specified range of the average, which is denoted by the heavy contour line. A + or – symbol indicates that the measured value is above or below the range denoted by the □ symbol. If a point is eliminated as an outlier, it is represented by a * symbol.

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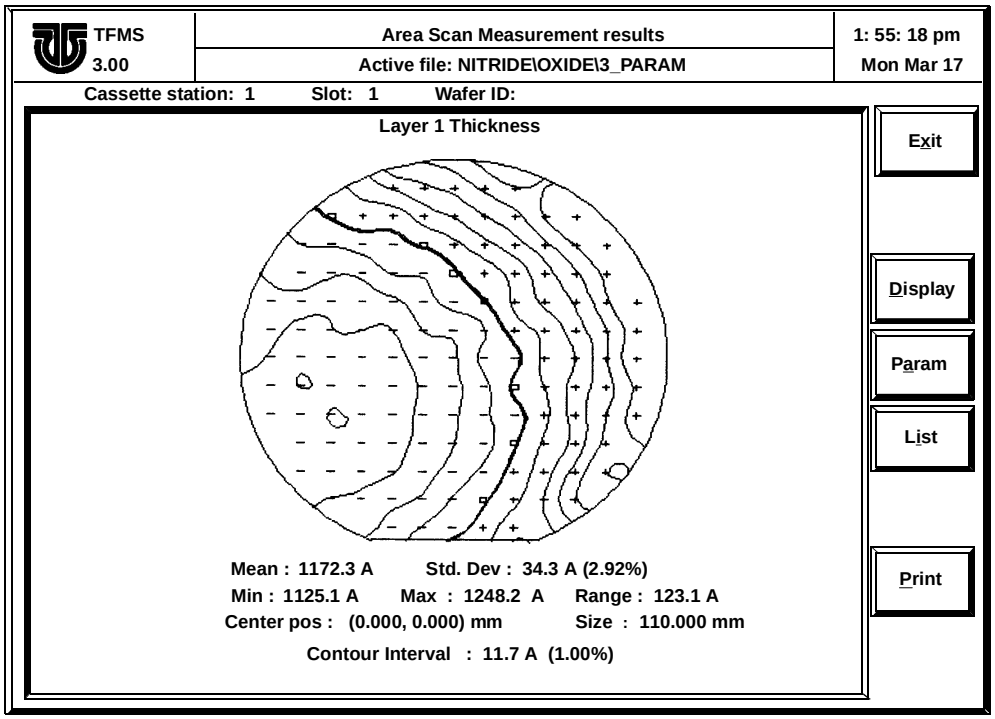
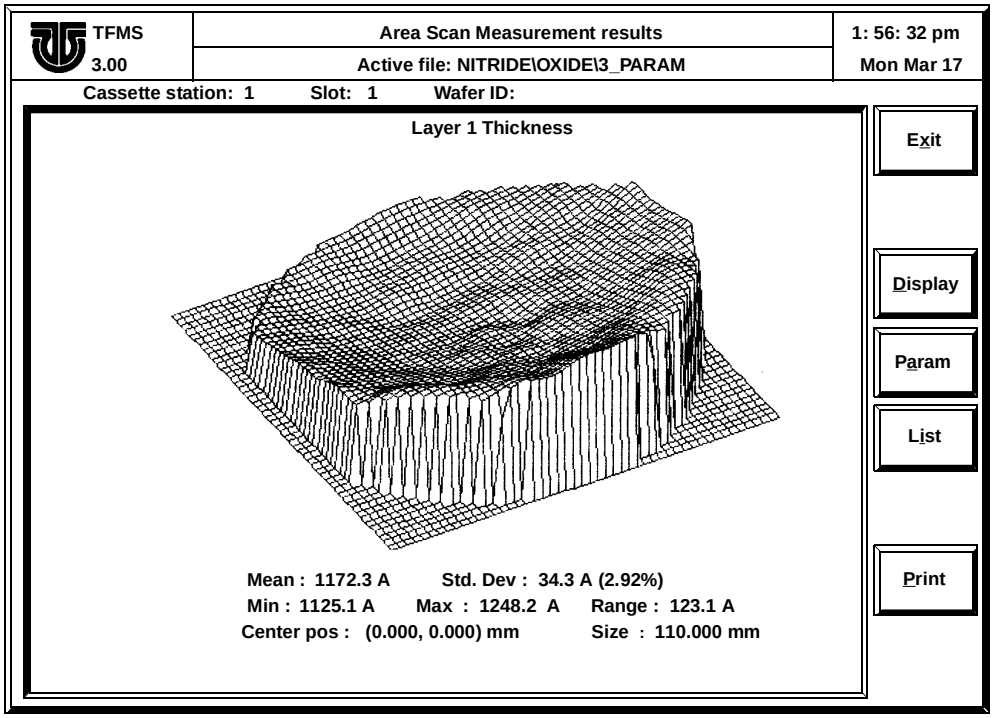
Figure 3.118 Area scan Measurement results window (contour display)



Measurement results windows for all measurement types have a *List* button in the right margin, as shown in the example in Figure 3.118. If you select the *List* button, the system prints the Wafer measurement report (described in Section 2, "Operation Summary"). You also see a *Param* button and a *Display* button (except in single point displays). If you select the *Param* button, the appropriate display parameters window appears where you can temporarily override the current display parameters, and also specify the measurement parameter you'd like to display. The *Display* button toggles between tabular and map displays (described later in this section).

A 3D map shows a pseudo-three-dimensional display of the measurement results, as shown in Figure 3.119 for the same data set shown in Figure 3.117.

Figure 3.119 Area scan Measurement results window (3D display)



For both display types, the outline of the wafer shape represents the diameter of the area scan or polar map, and the flat on the wafer shape indicates the orientation of the wafer flat (or notch, if a notch alignment was performed).

Initial display: Specifies either Tabular or Map for the initial measurement results window. If you select a tabular display, only the Initial display, Display measurement, Exclude outliers, and Outlier prob factor fields appear in the display parameters window. The tabular display is a data table, as shown in the example in Figure 3.120 for an area scan. The map display is either a contour or 3D map, as shown in the preceding examples and selected in the previous field. You can also specify the appearance of the initial display by selecting the Param button in the measurement results window and selecting the desired option. You can change display modes (tabular/map) in the measurement results window by toggling the Display button.

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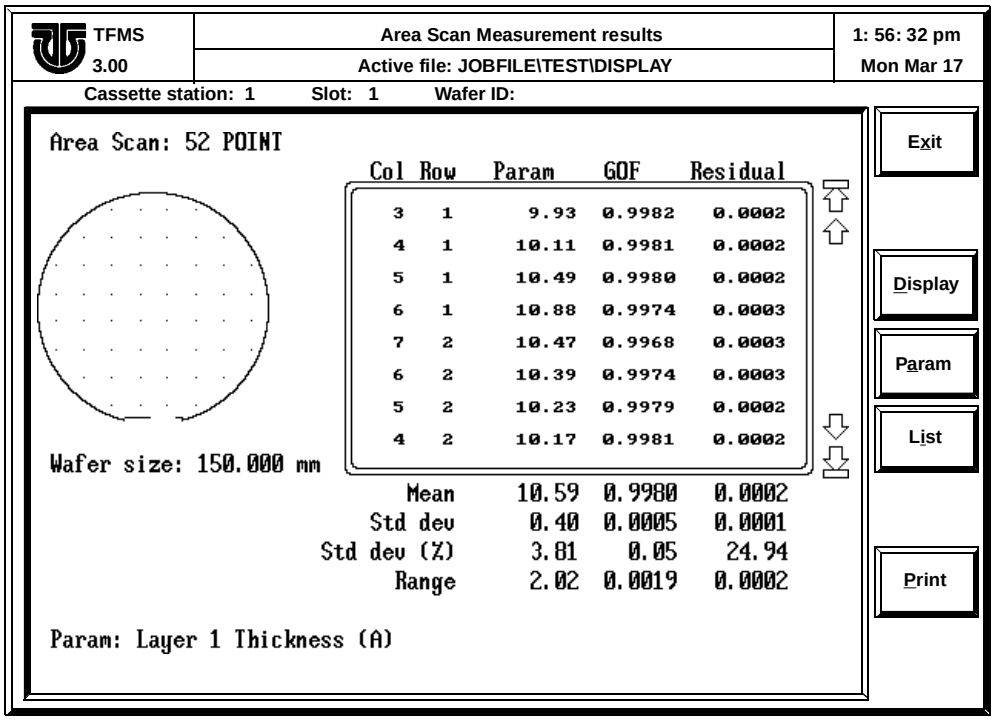
Figure 3.120 Area scan Measurement results window (Tabular display)



Display measurement:Specifies whether or not the system automatically displays a Measurement results window at the end of each wafer measurement. This parameter is identical to the *Display measurement* parameter in the Output Control window and works with the display timeout, as described earlier in this section.

Exclude outliers :Specifies whether or not the system applies statistical outlier processing to the measurement data and identifies and replots outliers. If you select *Yes* and a point is flagged as an outlier, the system re-calculates the displayed value based on interpolation between neighboring points. For a contour map display, a * symbol indicates an outlier.

Outlier prob factor :Specifies the probability that a good measurement point is identified as an outlier. The statistical calculation assumes a normal distribution of measurement data. This parameter is not used unless outlier exclusion is enabled (Exclude outliers = Yes). The default value, 0.05, is usually appropriate; exercise caution changing it.

Contour interval (%) :Specifies the minimum interval between contour lines in a contour display. The contour interval is expressed as a percentage of the average for the area scan or polar map. When the specified contour interval is too small, the display has too many contour lines. TFMS automatically chooses a large enough contour interval so that no more than 15 contour lines are displayed. If you want to display fewer contours, enter a value larger than the one that resulted in too many contours.

Box plot range (%):Specifies the range of measurement values depicted by a □ symbol on a contour map display. The box plot range is expressed as a percentage of the average for the area scan or polar map. A □ symbol represents measurements that are within the specified range (in the example, 1/4%) above or below the average value.

Scale factor :Specifies the relative aspect ratio (width/height) for a 3D display. The default value, 1.00, is usually appropriate.

Viewpoint R :Specifies the relative viewing distance for a 3D display. The default value, 10, is usually appropriate.

Viewpoint theta:Together with Viewpoint phi, specifies the direction from which the wafer is viewed for a 3D display. Theta is the inclination angle above the plane of the wafer (0° = horizontal, 90° = vertical). The default value, 65°, is usually appropriate.

Viewpoint phi :Together with Viewpoint theta, specifies the direction from which the wafer is viewed for a 3D display. Phi is the azimuth angle measured counterclockwise from the +X axis in an X/Y coordinate system with the origin at the center of the wafer and its -Y axis passing through the center of the aligned flat or notch. For the default value, 330°, the flat (notch) is oriented toward the lower left side of the 3D display.

Corr button:This button opens the Correlation Parameters window where you can correlate the measurement results, modify the current correlation setup, and/or toggle between a current or recalled correlated display. The *Corr* button appears in all display parameters windows, except for single point measurements. For more information on the Correlation function, see *Setup*/*Recipe*/*Correlation*, earlier in this section

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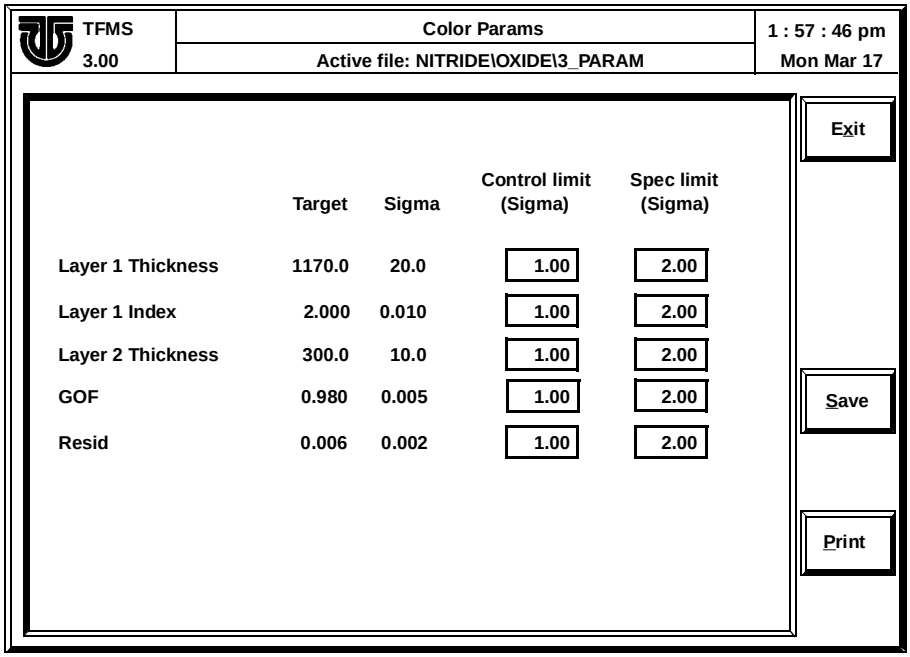
Color button: This button appears in the right margin of an Area scan or Polar map display parameters window. When you select the *Color* button, the Color parameters window appears, as shown in Figure 3.121.

Figure 3.121 Color Parameters window



In this window you can specify the use of color in area scan and polar map displays. You see a list of the measurement parameters at the left side of the window, along with target and sigma values for each parameter. You enter and edit these values in the SPC Specification window, described earlier in this section under the SPC reports menu. If the target and sigma values are zero, contour and 3D displays use only one color.

If the target and sigma values are nonzero, up to three colors are used, depending on the control and spec limits. If the display [i. e., points, contour lines (contour map), or grid lines (3D display)] is within the control limits, green is used. If the display is between the control and spec limits, yellow is used. If the display is outside the spec limits, red is used.

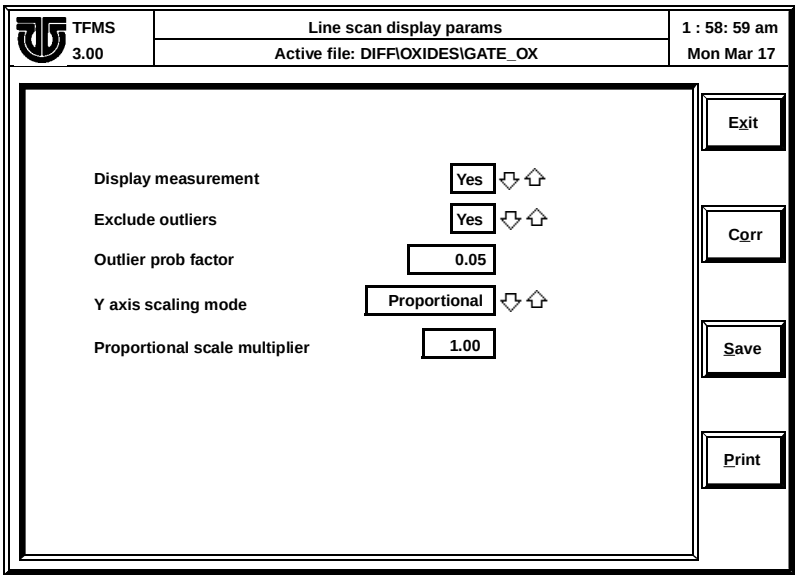
Control limit (sigma), Spec limit (sigma): Specify the control and spec limits, respectively, for the measurement or process. These limits are

represented as differences from the target value and are expressed as multiples of the standard deviation (sigma).

Display control/Line scan

When you select *Setup/Recipe/Data output/Display control* for a line scan measurement, the Line scan display parameters window appears. In this window, you can specify the appearance of line scan measurement results windows. Depending on your selection of the Y axis scaling mode (described in greater detail below), the window looks like the examples in Figures 3-122 (proportional), 3-124 (manual limit), or 3-125 (manual scale).

Figure 3.122 Line scan display parameters window (proportional display)



Display measurement : Specifies whether or not the system automatically displays a measurement results window at the end of each wafer measurement. This parameter is identical to the *Display measurement* parameter in the Output control window and the Area scan and Polar map display parameters windows. It works with the display timeout, as described earlier in this section under "Output Control."

Exclude outliers : Specifies whether or not the system applies statistical outlier processing to the measurement data and identifies and replots outliers. If you select Yes, and a point is flagged as an outlier, the system re-calculates the displayed

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value based on interpolation between neighboring points. For a line scan display, a * symbol indicates an outlier.

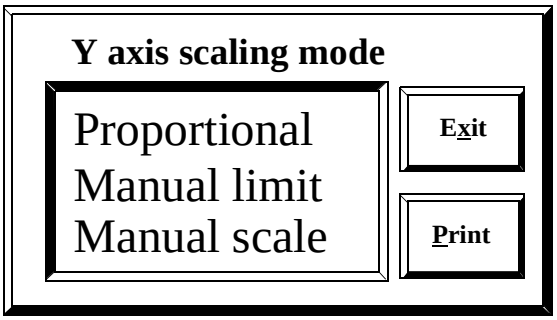
This parameter is identical to the Exclude outliers parameter that appears in the Area scan and Polar map display parameters windows.

Outlier prob factor :Specifies the probability that a good measurement point is identified as an outlier. The statistical calculation assumes a normal distribution of measurement data. This parameter is not used unless outlier exclusion is enabled (Exclude outliers = Yes). The default value, 0.05, is usually appropriate; exercise caution changing it.

This parameter is identical to the Outlier prob factor parameter that appears in the Area scan and Polar map display parameters windows.

Y axis scaling mode :Specifies the mode used to display the Y or vertical axis of the line scan. Three options appear in a pop-up menu, as shown in Figure 3.123.

Figure 3.123 Y axis scaling mode pop-up menu



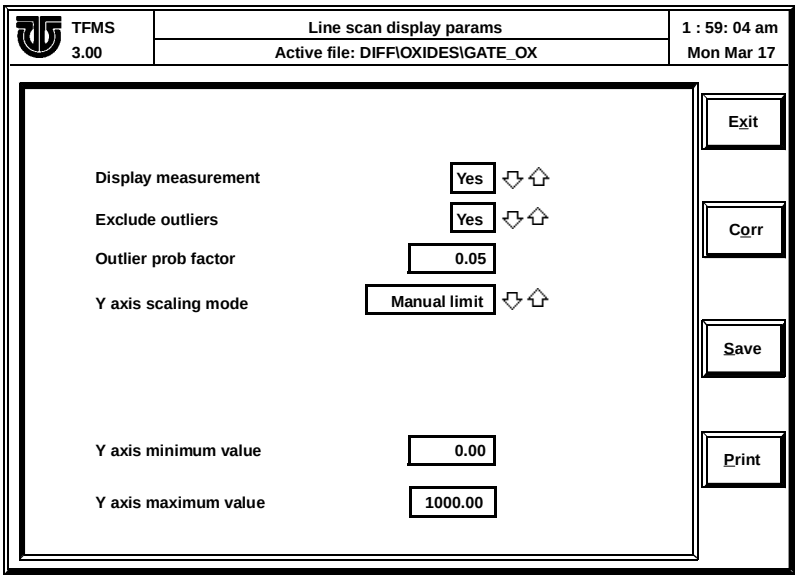
Depending on your selection, the Line scan display parameters window looks like the examples in Figures 3-122 (proportional), 3-124 (manual limit), or 3-125 (manual scale).

Proportional scale multiplier:Determines the size of the display for the proportional display mode shown in Figure 3.122.

This mode uses the normalized range of the measurement, i.e., the peak-to-peak value divided by the average and multiplies by the proportional scale multiplier. For example, if the normalized range of the data is 1%, and you enter a value of 1.00, the display fills 1% of the screen. If you enter a

value of 10.00, the display fills 10% of the screen. The maximum size of the display when fully expanded is 75% of the height of the graph.

Figure 3.124 Line scan display parameters window (manual limit display)

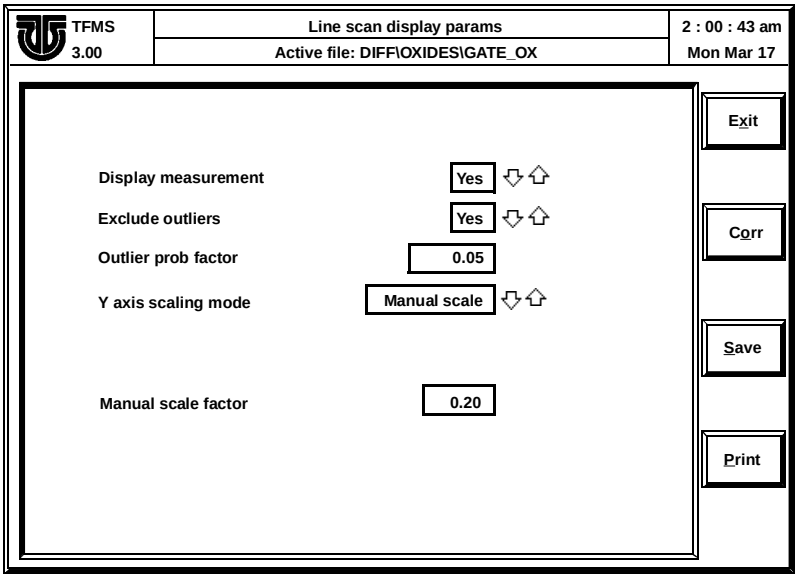


Y axis minimum value, Y axis maximum value: Specify the minimum and maximum values that appear along the Y axis of the graph for the manual limit mode shown in Figure 3.124. The system defaults to the minimum and maximum of the displayed data set. If there is no current data set, as in Figure 3.124, 0. and 1000. appear in these fields. This mode is useful if you'd like to display several data sets using exactly the same Y axis limits or if you'd like to display only a portion of the measurement range.

If you want to modify the default manual limits, your new y axis minimum and maximum entries must fall within the range of values for the parameter you want to display. When you select the *Param* button in a line scan measurement results window, an additional display option appears, *Measurement parameter.* When you select a different parameter to display (film layer, GOF, etc.), always note that parameter's minimum/maximum values before you enter your new manual limits. If you don't know the range of values, change to another display mode (proportional or manual scale) and note the minimum/maximum values used to plot the selected parameter. These are the default range of values for the corresponding parameter. If your entries are incorrect, a message informs you of this.

Manual scale factor: Specifies the size of the display for the manual scaling mode shown in Figure 3.125. This mode expresses the size as a fraction of the vertical dimension of the graph. For example, if you enter 0.20 the data display fills 20% of the height of the graph. The maximum size of the display when fully expanded is 75% of the height of the graph.

Figure 3.125 Line scan display parameters window (manual scale display)

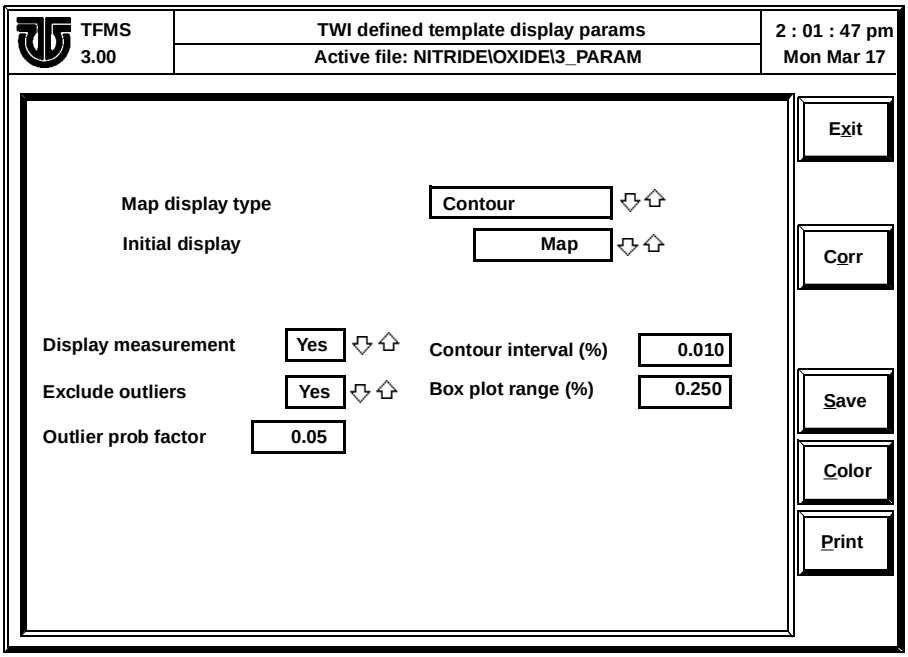


Display control/Template

When you select *Setup*/*Recipe*/*Data output*/*Display control* for a template measurement, the template display parameters window appears, which looks similar to the example in Figure 3.126 for a TWI defined (standard) template. In this window, you can specify the appearance of template measurement results windows. The parameters in this window are identical to the area scan and polar map display parameters described earlier in this section. However, there are some limitations for template map displays. In some cases, when you try to display a template map, a message may appear on the screen indicating that the system cannot perform this function for the distribution of points selected. This message also lists the possible causes for the invalid map display.

The Die template display parameters window has an additional parameter, *Data filter*. For a complete description of this parameter, see Section 4, "Pattern Recognition Functions.

Figure 3.126 Template display parameters window (TWI defined template)



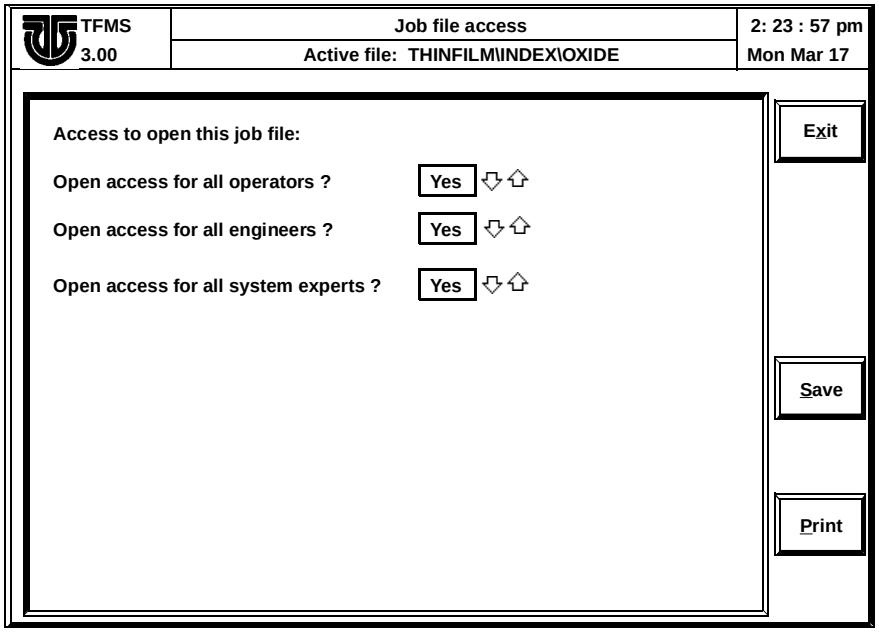
3.7.12 Vision (VP Models only)

This option requires a VP. It allows you to configure parameters for different types of pattern recognition operations. For a complete description of the *Vision* option, see Section 4, "Pattern Recognition Functions."

3.7.13 Access

When you select *Setup*/*Recipe*/*Access*, the Job file access window appears, as shown in Figure 3.127. In this window, you can limit access to your job file by user level (except for system managers and TWI field staff). When you deny access to your job file, all users operating at the specified level(s) cannot open your job file. For job file chains, the system checks the access status for each of the job files in the chain. If a user does not have access to one or more job files in the chain, a message appears, which lists the job file(s) that cannot be opened by the current user.

Figure 3.127 Job file access window



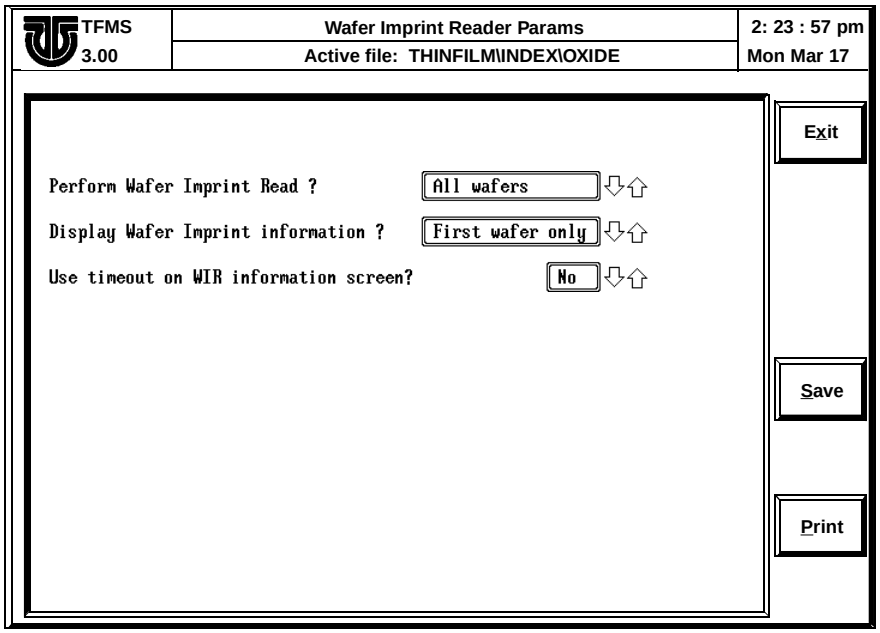
Open access for all operators, engineers, system experts

In these fields, you can allow or deny access to your job file by selecting *Yes* or *No* for the corresponding user level. The last field, *Open access for all system experts*, only appears if the owner of the job file has System Expert or System Manager level privileges.

3.7.14 Wafer Imprint (WIR systems only)

When you select *Setup*/*Recipe*/*Wafer Imprint* on a WIR equipped system, the Wafer Imprint Reader Parameters window appears, as shown in Figure 3.128.

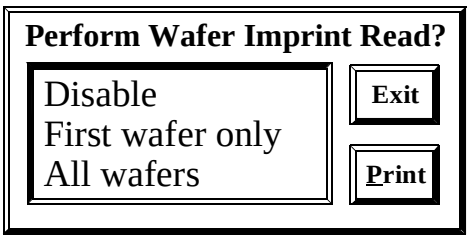
Figure 3.128 Wafer Imprint Reader Parameters window



Perform Wafer Imprint Read

This specifies whether the system reads wafer imprints at run time and if so, if it reads all wafers or only the first wafer loaded. You can select from three options, as shown below.

Figure 3.129 Perform Wafer Imprint Read pop-up menu



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Display Wafer Imprint information?

This specifies whether the system displays the wafer imprint information at run time, and if so, if it displays this information for all wafers or only for the first wafer loaded.

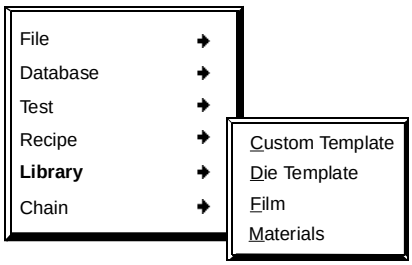
Use timeout on WIR information screen?

This specifies whether the WIR information display automatically times out (expires) after a specified time. If you select *Yes*, the *Timeout (seconds*) field appears where you can enter the desired timeout interval. The maximum timeout interval is 30 seconds.

3.8 LIBRARY MENU

When you select *Setup*/*Library*, the Library menu appears with four options, as shown in Figure 3.130. These options provide access to the corresponding Library Maintenance windows where you can perform a number of library related functions. The *Die template* option is only functional on VP systems, and the *Materials* option is only accessible at the System Expert level.

Figure 3.130 Library menu

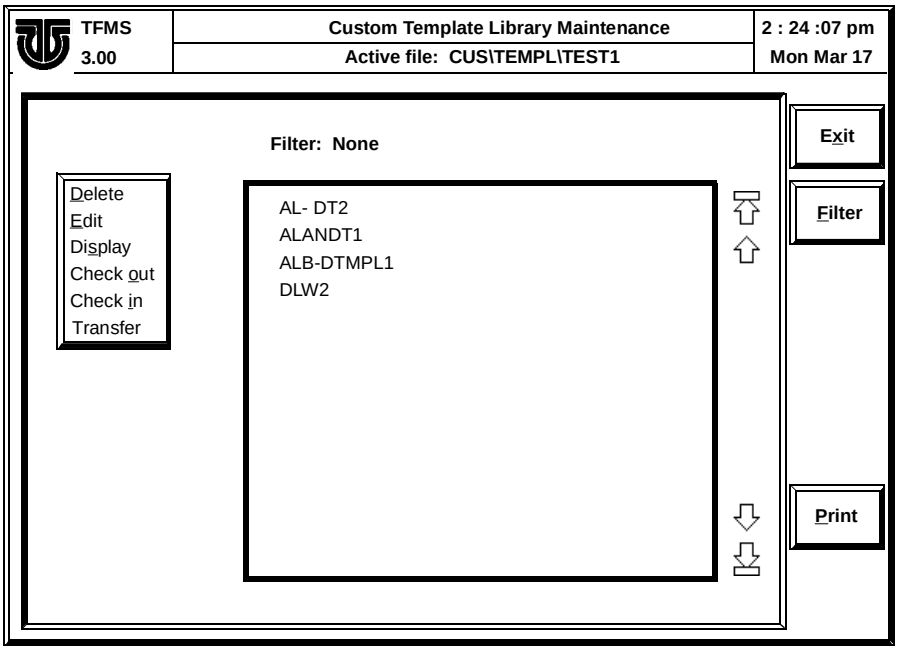


3.8.1 Custom Template

When you select *Setup*/*Library*/*Custom template*, the Custom Template Library Maintenance window appears. You see a Function menu at the upper left side of the window, the Custom template list appears in alphabetical order in the center, and a *Filter* button appears in the right margin, as shown in Figure 3.131. In this window, you can add a custom template to the Custom template library so it is accessible to other users who can copy it into their job files. You can also copy a library custom template into your job file, display a custom template and its related data, modify the library information, and rename or delete any of your custom

templates. The *Transfer* option is only accessible at the System Manager level and is described in Section 7.

Figure 3.131 Custom Template Library Maintenance window



Filter button

The *Filter* button allows you to view only selected templates in the Custom template list. These templates are linked by a common group of characters called a keyword. The default keyword is the User ID belonging to the user who copied ("checked in") the template to the library (creating a new keyword and "check in" are described later in this section). When you select the *Filter* button, a keyboard window appears where you enter the desired keyword (e.g., JIM). After entering a keyword, the Custom template list reappears, displaying only those custom templates associated with that keyword. After "filtering" the list, you can return to the complete library of templates by selecting the *Filter* button again. When the keyboard window appears, select the *Enter* button without making an entry to display the complete list of custom templates.

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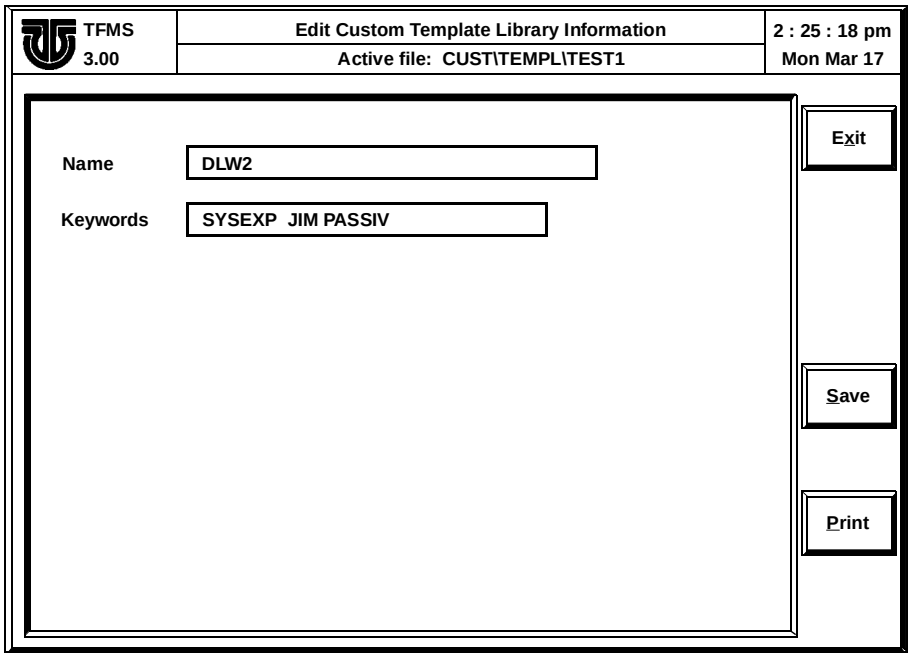
Delete

When you select a custom template and then select *Delete* in the Function menu, a confirmation dialog box appears. If you select *Ok*, the system deletes your selection. If you do not have deletion privileges, a message informs you.

Edit

When you select a custom template and then select *Edit* in the Function menu, the Edit Custom Template Library Information window appears, where you can edit the library information for the selected template, as shown in Figure 3.132. If you do not have editing privileges, a message informs you of this.

Figure 3.132 Edit Custom Template Library Information window



Name : In this field, you can enter a new name for the selected template.

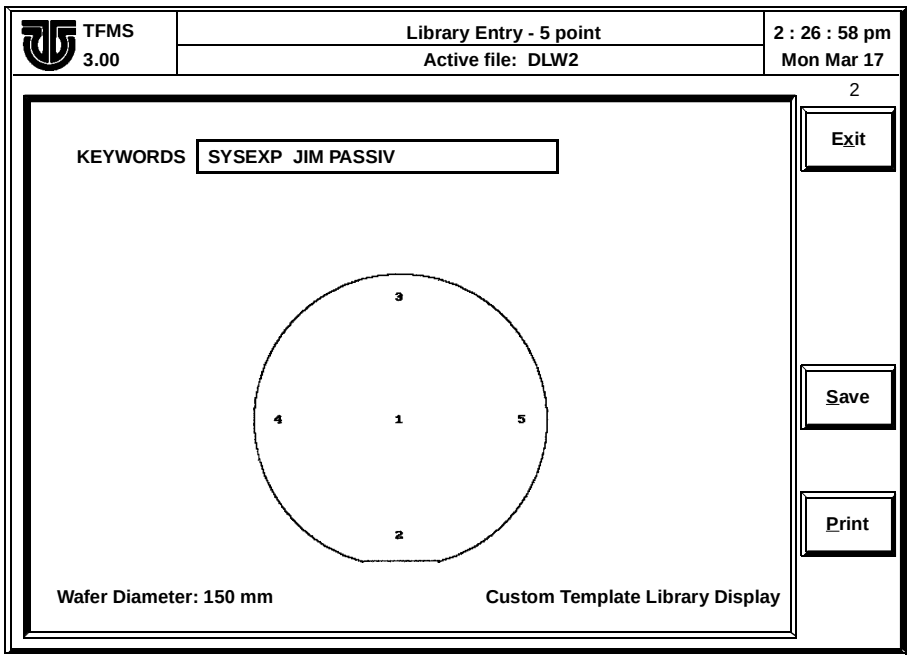
Keywords : This field displays the User ID and any other keywords entered by the user who copied ("checked in") the template to the library. You use keywords along with the *Filter* button to display only specific templates, as described earlier in this section.

When you select the *Keywords* field, a keyboard window appears displaying your User ID as the default keyword. You can enter a new keyword by typing a space followed by one or more words (e.g., JIM PASSIV) after the User ID, and then selecting the *Enter* button in the keyboard window. Alternatively, you can delete the User ID and replace it with some new keywords. You must select the *Save* button to save your new keywords. After you enter a new keyword, the Edit Custom Template Library Information window reappears with your new keywords displayed in the *Keywords* field.

Display

When you select a custom template and then select *Display* in the Function menu, the Library Entry window appears, as shown in the example in Figure 3.133. This window displays the selected custom template and related data. You also see the *Keywords* field at the top of the window (described above). In this window, you can consider different options if you're thinking about changing your job file's current template.

Figure 3.133 Library Entry window



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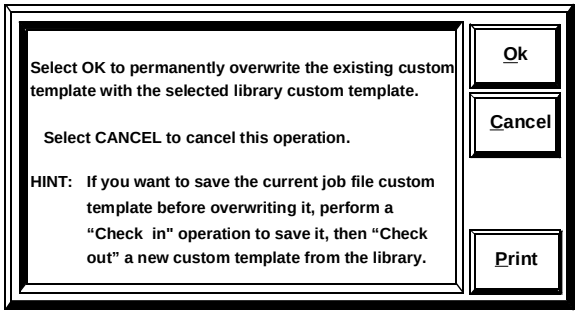
Check out

You can copy or " Check out" a library template into a job file setup for a Custom template measurement. When you select the desired template in the template list and then select *Check out* in the Function menu, the Check out dialog box appears, as shown in Figure
3-134.

Figure 3.134 Check out dialog box


Select OK to permanently overwrite the existing custom template with the selected library custom template.
Select CANCEL to cancel this operation.
HINT: If you want to save the current job file custom template before overwriting it, perform a "Check in" operation to save it, then "Check out" a new custom template from the library.
Ok
Cancel
Print

If you select *Ok* in the dialog box, the system copies the selected template into your job file, overwriting the existing template if the job file already contains one. If you want to save the existing template, add it to the library by performing a "Check in" operation before checking out the new template. This is your private copy and it includes mask alignment and all related data for the selected custom template. You can use a library custom template as it is or alter it and then use it. You can add (Check in) the altered version to the custom template library under a different name.

Check in

You can add or Check in the active job file's custom template to the library by selecting *Check in* in the Function menu. A keyboard window appears where you can enter a unique name for your custom template using up to 30 characters. After you enter the name of your custom template, it appears in the custom template list.

You cannot create and use a custom template unless a job file is open.

Transfer

This option is only accessible at the System Manager level. For a description, see Section 7.

3.8.2 Die Template (VP Models only)

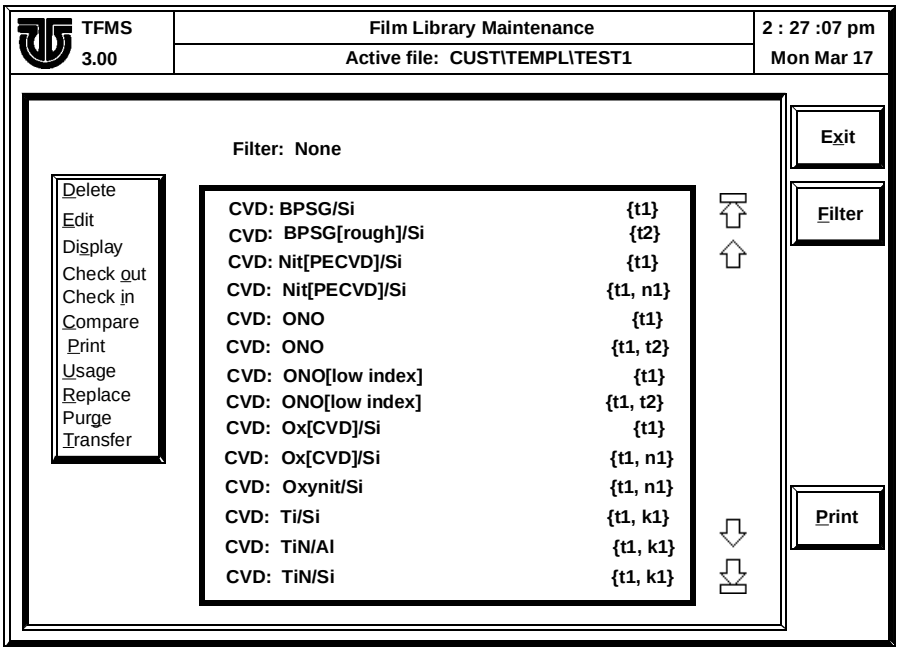
When you select *Die Template* in the Library menu, the Die Template Library Maintenance window appears. The die template library operates the same as the custom template library. For additional information on the Die template library, see Section 4, "Pattern Recognition Functions."

3.8.3 Film

When you select *Setup*/*Library*/*Film*, the Film Library Maintenance window appears, as shown in Figure 3.135. In some cases, a System Manager may remove Engineer level access to this window and its functions. If you select *Film* and do not have the necessary access privileges, a message informs you of this.

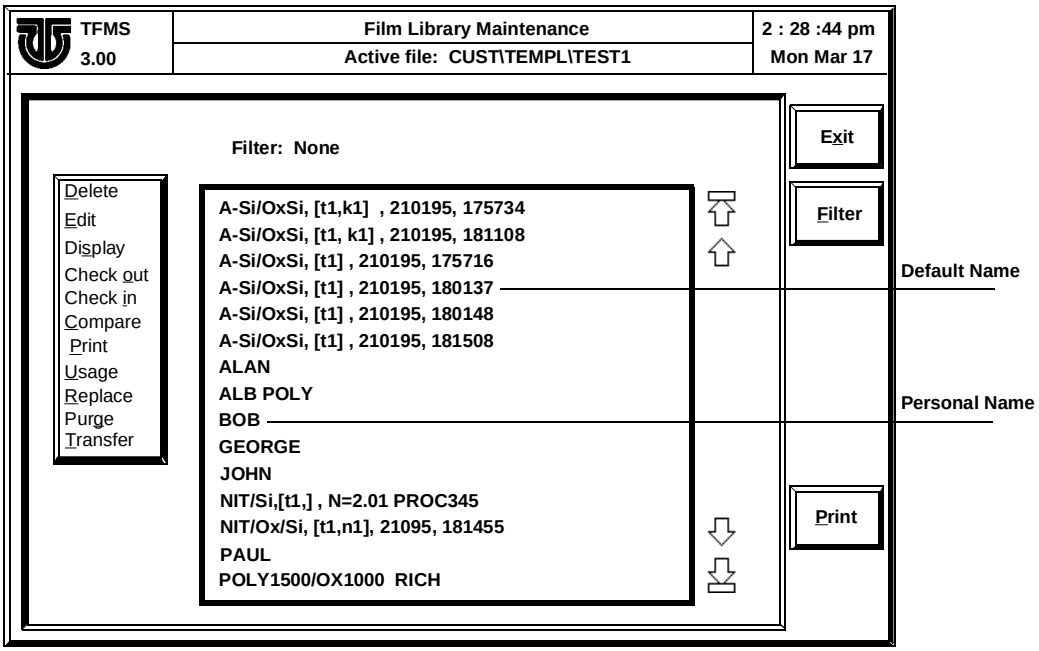
In this window, you can add a film stack to the Film library so it is accessible to other users who can copy it into their job files. You can also copy a library film stack into your job file, display and compare film stacks and related data, display other job files that use the selected film setup, and edit or delete any of your film stacks. You see a Function menu at the upper left side of the window, the list of TWI defined film stacks appears in alphabetical order by process type and film type in the center, and a *Filter* button appears in the right margin. If any user-defined film recipes are saved, they are listed in alphabetical order at the end of the TWI defined film stack list, as shown in Figure 3.136. The *Replace* , *Purge*, and *Transfer* options are only accessible at the System Manager level and are described in Section 7.

Figure 3.135 Film Library Maintenance window (TWI defined standard films)



When a user saves a personal film stack in the Film parameters window (as described earlier in this section), the system enters the new film stack in the library with a default name that indicates the film layers, parameters to be measured, date, and time, as shown in the example in Figure 3.136. This entry appears in alphabetical order with any other user-defined films, following the list of standard film stacks. You can modify the system's default entry and enter a personal name (shown in the example in Figure 3.136) by using the Edit function in the Film Library Maintenance window, described later (after the Delete function).

Figure 3.136 Film Library Maintenance window (User defined films)



Delete

When you select a personal film stack (defined by you) and then select *Delete* in the Function menu, a confirmation dialog box appears. Select *Ok* in the dialog box to delete the selected stack. If you do not have deletion privileges, a message informs you of this.

Edit

When you select a personal film stack and then select *Edit* in the Function menu, the Edit Film Library Information window appears, as shown in the example in Figure 3.137. In this window, you can change the name of the selected film stack and enter keywords and comments. Renaming a film stack can be helpful if the system provided a default label (e.g., by film, param, date, & time) when saving the film or file. A personal film name is easier to recognize when you browse through the library. After renaming the film stack, select the *Save* and *Exit* buttons to return to the Film Library Maintenance window.

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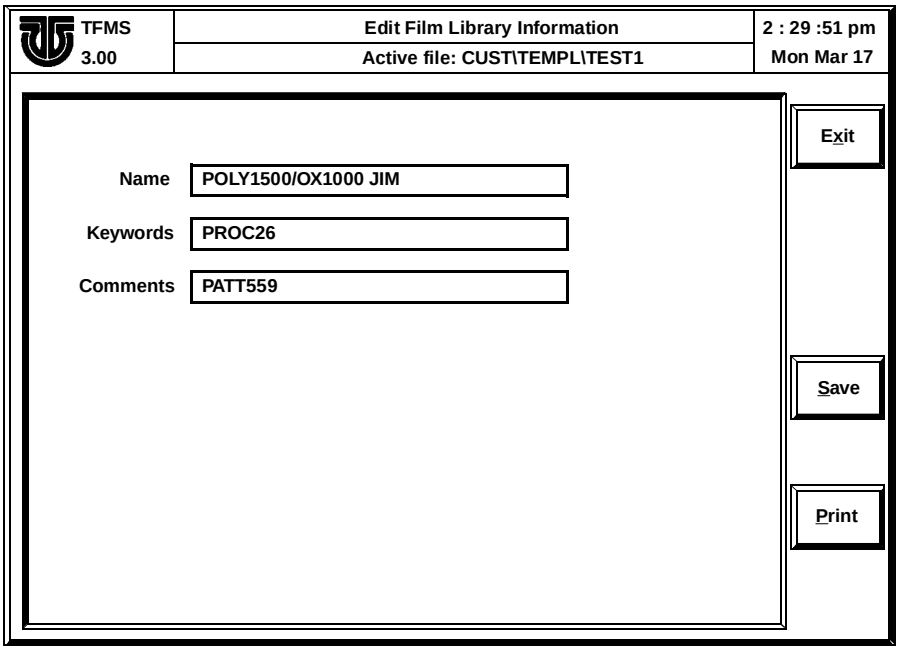
Figure 3.137 Edit Film Library Information window



Keywords :This field displays the User ID and any other keywords entered by the user who checked in the film stack. You use keywords along with the *Filter* button to display only specific film stacks.

When you select the *Keywords* field, a keyboard window appears displaying your User ID as the default keyword. You can enter a new keyword by typing a space followed by one or more words (e.g., PROC26) after the User ID, and then selecting the *Enter* button in the keyboard window. Alternatively, you can delete the User ID and replace it with some new keywords. After entering the new keyword, select the *Save* and *Exit* buttons to return to the Film Library Maintenance window.

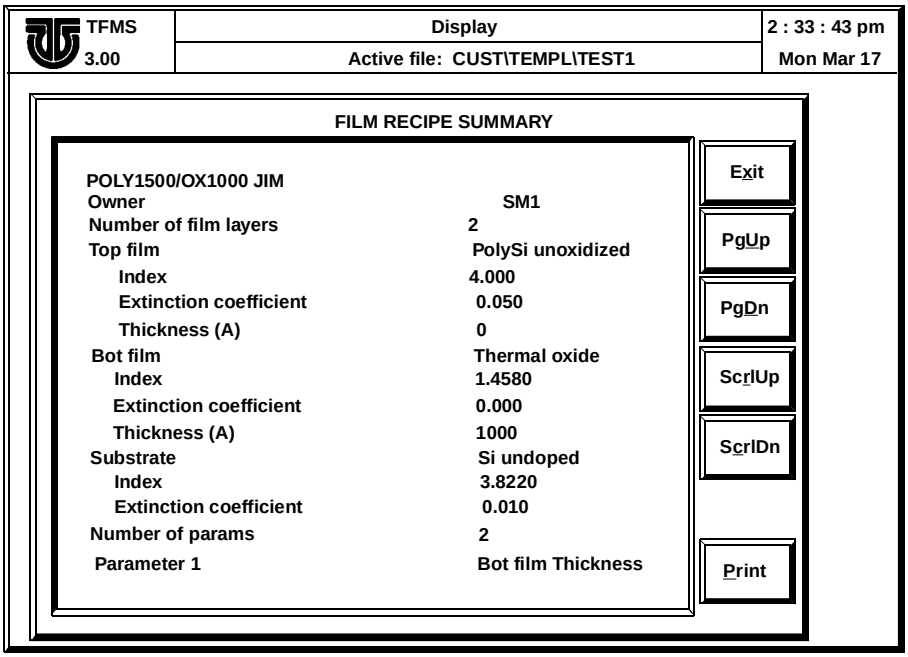
Comments:The *Comments* field displays optional information entered by the user. When you select the *Comments* field, a keyboard window appears where you can enter any comments you like. After entering your comments, select the *Save* and *Exit* buttons to return to the Film Library Maintenance window.

Display

When you select a film stack and then select *Display* in the Function menu, the Film Recipe Summary window appears, as shown in the example in Figure 3.138

for a User defined film stack. This window displays the selected film stack's parameters and related data. You can use the *PgUp/Dn* and *ScrlUp/Dn* buttons to view the data for all the film parameters. In this window, you can consider different options if you're thinking about changing your job file's current film stack.

Figure 3.138 Film Recipe Summary window



Check out

You can copy or Check out a Film library film stack into a job file setup. When you select the desired film stack in the Film stack list and then select *Check out* in the Function menu, the Check out dialog box appears, as shown in Figure 3.139. Select *Ok* in the Check out dialog box if you want the system to copy the selected film stack into your job file and overwrite any existing film stack. If you want to save the existing film stack, add it to the library by performing a Check in operation before checking out the new film stack. This is your private copy. You can use this film stack as it is or alter it and then use it. You can add the altered version to the Film library under a different name.

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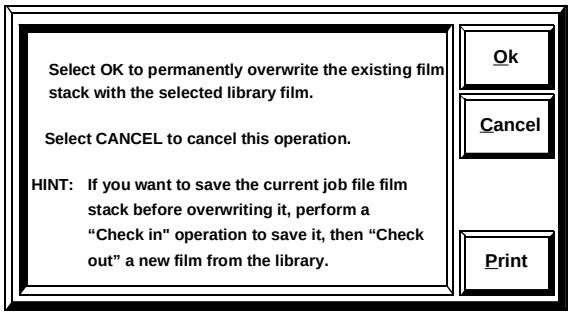
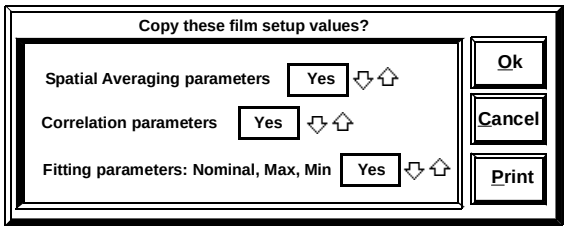
Figure 3.139 Check out dialog box


Select OK to permanently overwrite the existing film stack with the selected library film.
Select CANCEL to cancel this operation.
HINT: If you want to save the current job file film stack before overwriting it, perform a "Check in" operation to save it, then "Check out" a new film from the library.
Ok
Cancel
Print

After you select *Ok* in the Check out dialog box, another dialog box appears that asks whether you want to copy the selected film stack's setup values for the spatial averaging, correlation, and fitting parameters, as shown in Figure 3.140. Select *Yes or No* and then select *Ok* to include or exclude any of these setup values. If you select *No* for any of these parameters, your job file retains its original setup value for that parameter.

Figure 3.140 Copy film setup values dialog box



When you use the *Library* button in the Film parameters window to select a film stack, this dialog box does not appear and the system copies all the film setup values.

Check in

You can add or "Check in" the active job file's film stack to the library by selecting *Check in* in the Function menu. A keyboard window appears where you can enter a personal name for your film stack using up to 30 characters. After you enter the name of your film stack, it appears in the Film stack list. You can use this function to enter the desired name instead of saving the film stack in the Film parameters

window or using the *Setup*/*File*/*Save* option, which provides a default name by film, params, date, and time.

Compare

When you select *Compare* in the Function menu, and then select two entries in the Film stack list, the system displays the parameters that are different in the two film setups. This function is very useful if the two film stack entries display the same film layer configuration and parameter information. Currently, this function does not identify differences in the spatial averaging setup values.

Print

When you select *Print* in the Function menu, a dialog box appears asking if you want to print the Film recipe summary. If you select *Ok*, the system prints the Film recipe summary.

Usage

When you select a film stack and then select *Usage* in the Function menu, the Usage window appears, displaying all the job files that use the selected film stack.

Replace/Purge/Transfer

These options are only accessible at the System Manager level and are described in Section 7.

Filter button

When you select the *Filter* button in the Film Library Maintenance window,

a keyboard window appears. When you enter a keyword in this keyboard window (e.g., JIM), the Film stack list only displays the film stack(s) associated with that keyword.

After using the *Filter* button, you can view all the film stacks by selecting the *Filter* button again. A keyboard window appears where you select the *Enter* button without making an entry. The Film Library Maintenance window reappears with all of the Film stacks displayed in the Film stack list.

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The system provides the following three special keywords:
TWI = displays only TWI defined films
USER = displays only user-defined films with user-created (personal) names
AUTO = displays only user-defined films with automatic (default) names

3.8.4 Materials (System Expert level only)

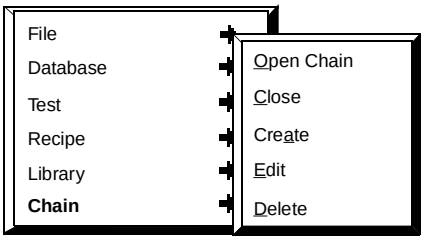
At the System Expert level, when you select *Materials* in the Library menu, the Materials Library Maintenance window appears. For a complete description of the Materials Library, see Section 6, "System Expert Functions."

(The *Materials* option may not be included in the initial TFMS 3.00 release, but will be included in future TFMS 3.00 upgrades).

3.9 CHAIN MENU

When you select *Setup*/*Chain*, the Job file chain menu appears as shown in Figure 3.141. Job file chaining allows you to perform automated wafer measurements that use multiple recipes from different job files. The system runs the desired job files in sequence for each of the selected wafers, and measures these wafers in their slot sequence for the most time efficient measurements. Each job file chain is saved in a Job file chain library and its ownership is secured like individual job files. Only a System Manager can change the ownership of a job file chain.

Figure 3.141 Job file chain menu

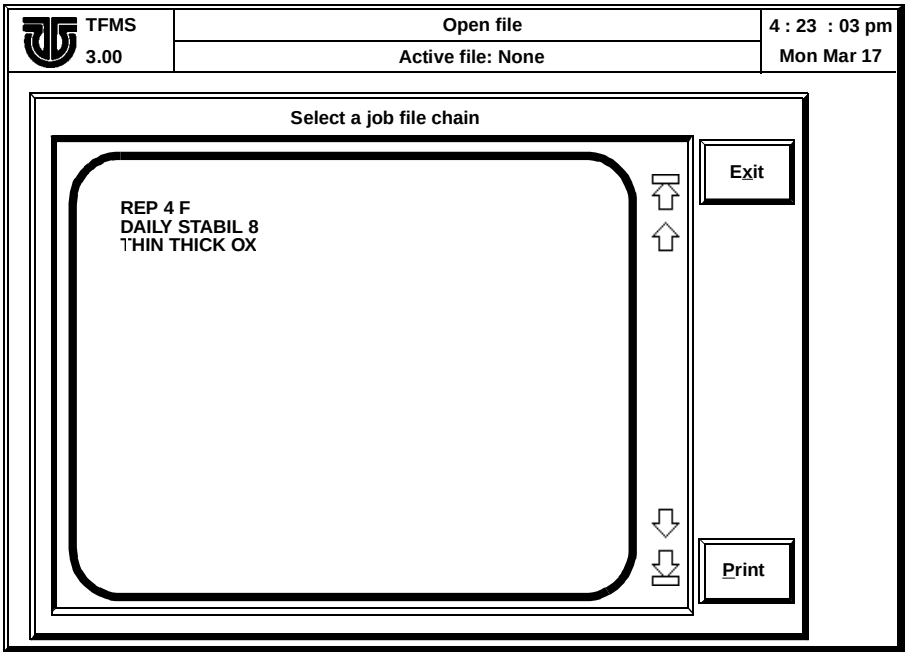


3.9.1 Open Chain

When you select *Setup*/*Chain*/*Open Chain* , the Select a job file chain window appears, displaying all the current job file chains, as shown in Figure 3.142. In this window you can select a job file chain. When you select a job file chain, it becomes the active chain and its name appears as the Active chain in the Status

area. You can also open this window by selecting the *Chain* button in the Open File window, shown earlier in this section.

Figure 3.142 Select a job file chain window



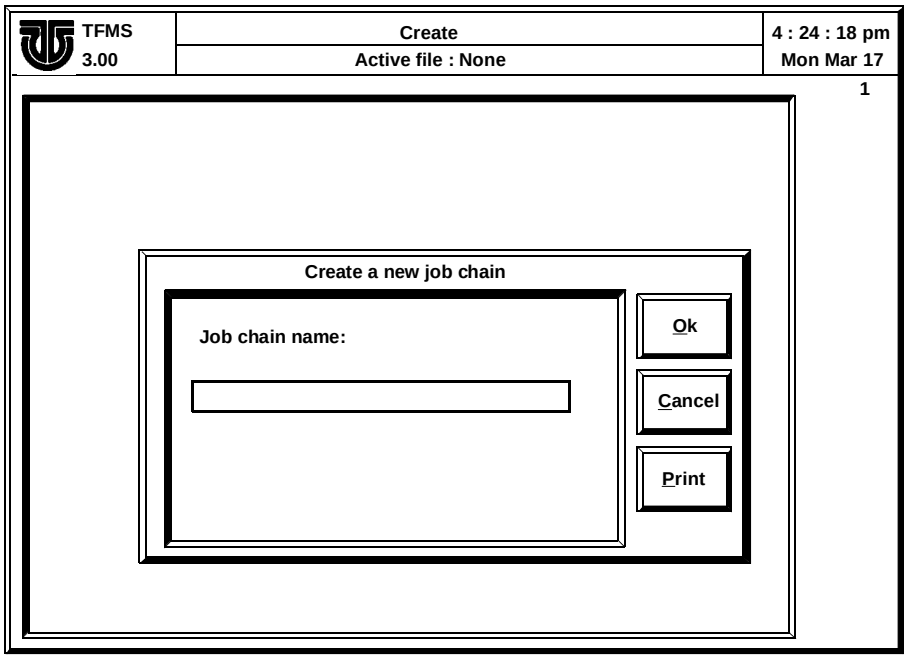
3.9.2 Close

When you select *Close* in the Job file chain menu, the active job file chain closes.

3.9.3 Create

When you select *Setup*/*Chain*/*Create* , the Create a new job chain window appears, as shown in Figure 3.143.

Figure 3.143 Create a new job chain window



Job chain name

When you select the *Job chain name* field, a keyboard window appears where you can enter a name for your job file chain (e.g., Chain-3 files).

3.9.4 Edit

When you select *Setup*/*Chain*/*Edit*, the Modify job file chain entry window appears with the name of the selected chain displayed as the Active chain in the Status area, as shown in Figure 3.144. A Function menu appears in the upper left corner and an *Info* button appears in the right margin. In this window, you can select the job files that you'll run as a chain, along with the corresponding cassette and slot information. You can also alter this information, delete job files from the chain, and configure additional job file chain parameters (printing, cycling, etc.). These entries override each job file's standard setup for the corresponding parameters, while all other job file parameters remain constant.

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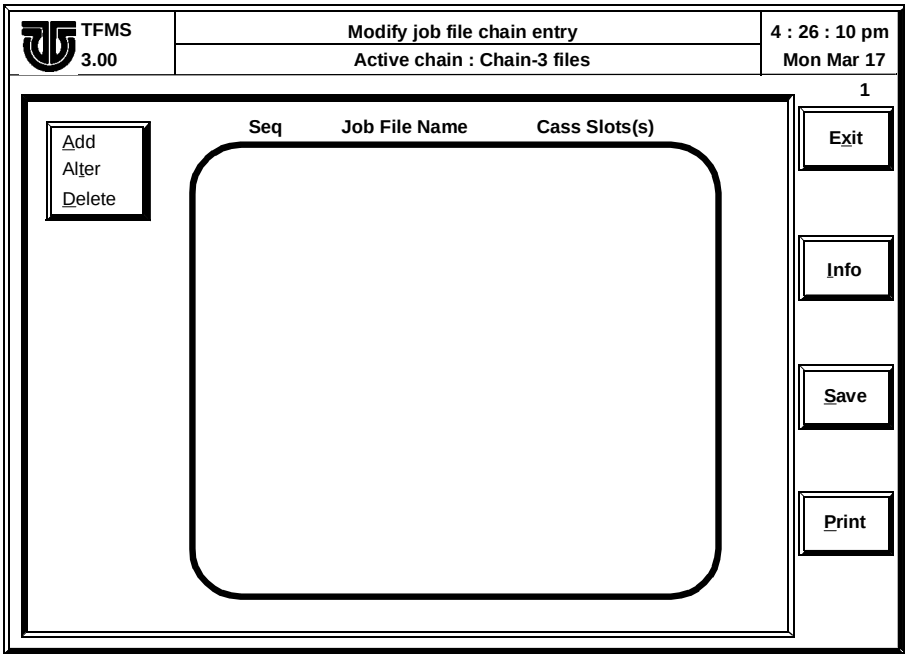
Figure 3.144 Modify job file chain entry window



Add

When you select *Add* in the Modify job file chain entry window Function menu, the Add job file chain entry window appears, as shown in Figure 3.145. In this window, you can add a job file to the chain and enter the desired parameters.

Sequence: Specifies the order in which the system prints the selected job file's measurement results in the Chain summary report. The system performs measurements in the order of increasing slot numbers, independent of the job file sequence.

Job file name: When you select the *Job file name* field, the Select window appears, as shown in the example in Figure 3.146. In this window, you select the first job file for your job file chain. After you select the first job file, the Add job file chain entry window reappears with the selected job file name displayed in the *Job file name* field.

Cassette: Specifies the cassette station(s) used to load wafers for measurement with the job file's recipe.

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Figure 3.145 Add job file chain entry window

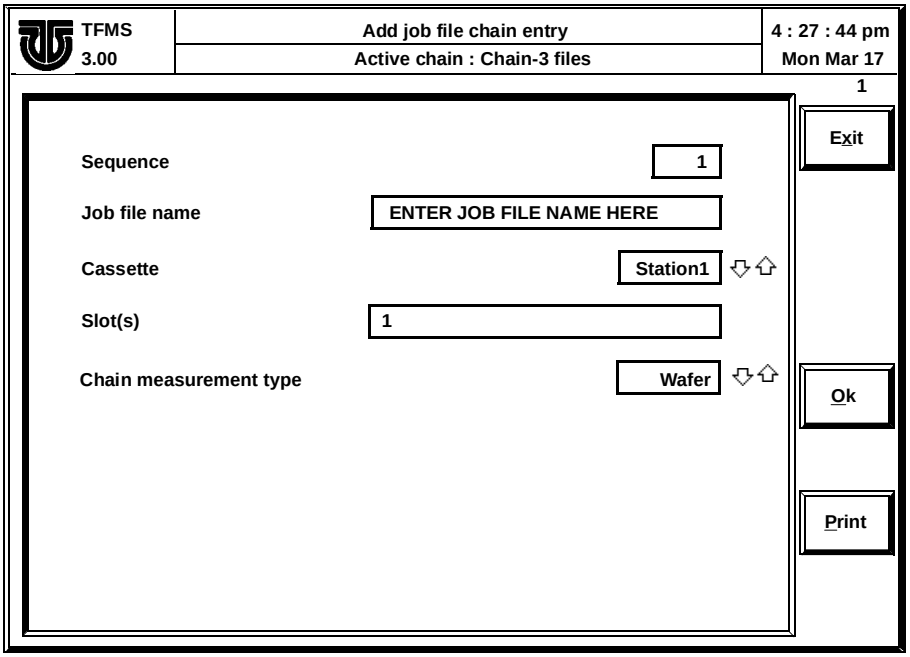
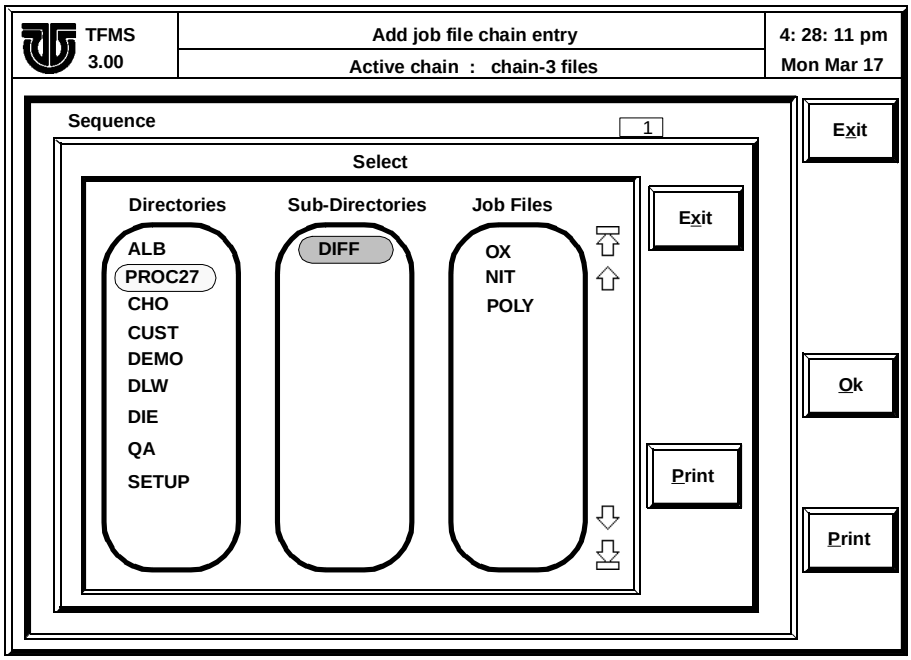


Figure 3.146 Select window



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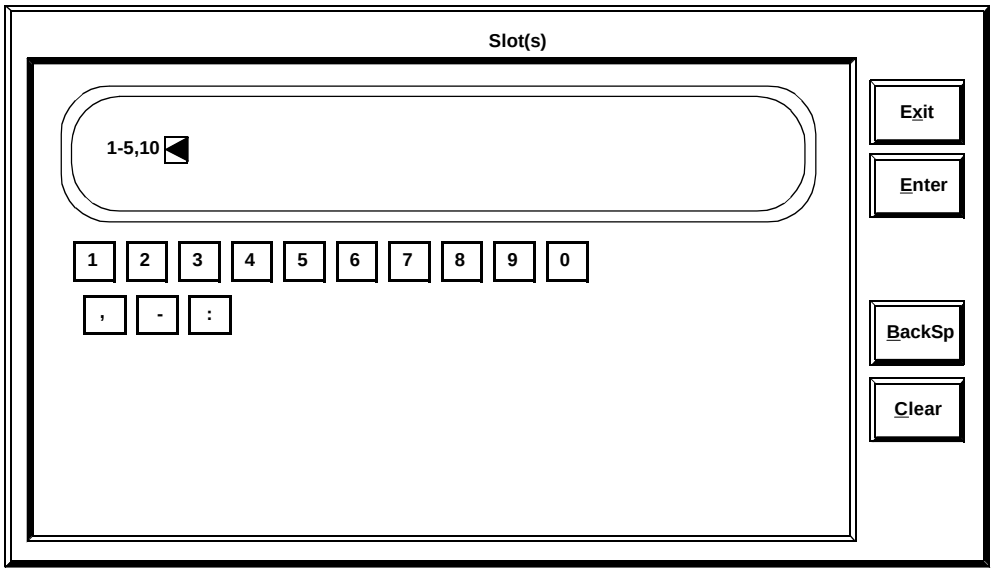
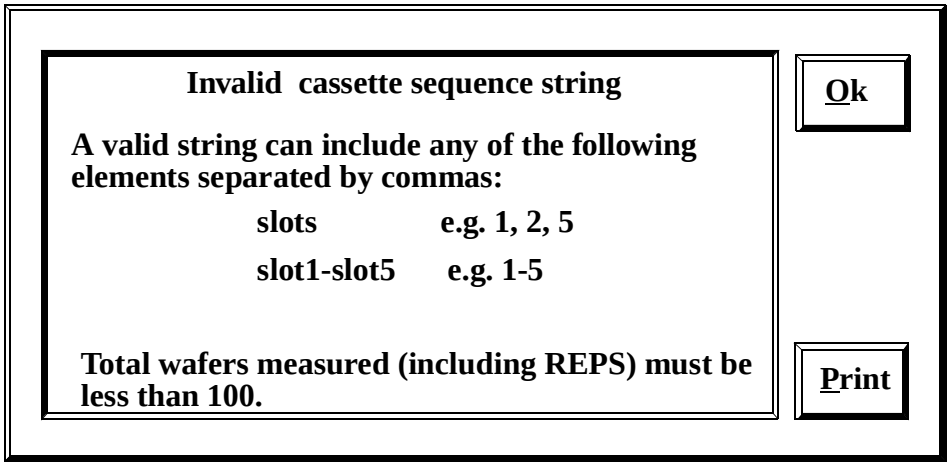
Slot(s): Specifies the job file's wafer measurement sequence by slot number. When you select this field, the Slot(s) keyboard window appears, as shown in Figure 3.147. You use the characters in this window to enter one or more wafer sequence strings. A number indicates the wafer slot, a dash separates the beginning and end of a sequence string, and a comma separates sequence strings. For example, if you enter 1-5, 10, the system measures wafers 1 through 5, followed by wafer 10.

Figure 3.147 Slot(s) keyboard window



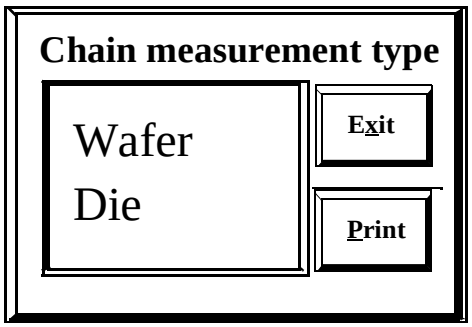
If you enter an invalid cassette sequence string, a dialog box appears with a reminder message, as shown in Figure 3.148. The colon is non-functional for chain measurement wafer sequence strings.

Figure 3.148 Invalid cassette sequence string dialog box


Invalid cassette sequence string
A valid string can include any of the following elements separated by commas:
slots e.g. 1, 2, 5
slot1-slot5 e.g. 1-5
Total wafers measured (including REPS) must be less than 100.
Ok
Print

Chain measurement type: When you select the *Chain measurement type* field, two options appear, *Wafer* and *Die*, as shown in Figure 3.149. *Wafer* specifies a standard job file chain measurement. If your system has a vision processor, *Die* specifies that the wafer remains on the stage and is not unloaded/reloaded/re-aligned when the system performs multiple job file measurements using the same wafer and the same die pattern.

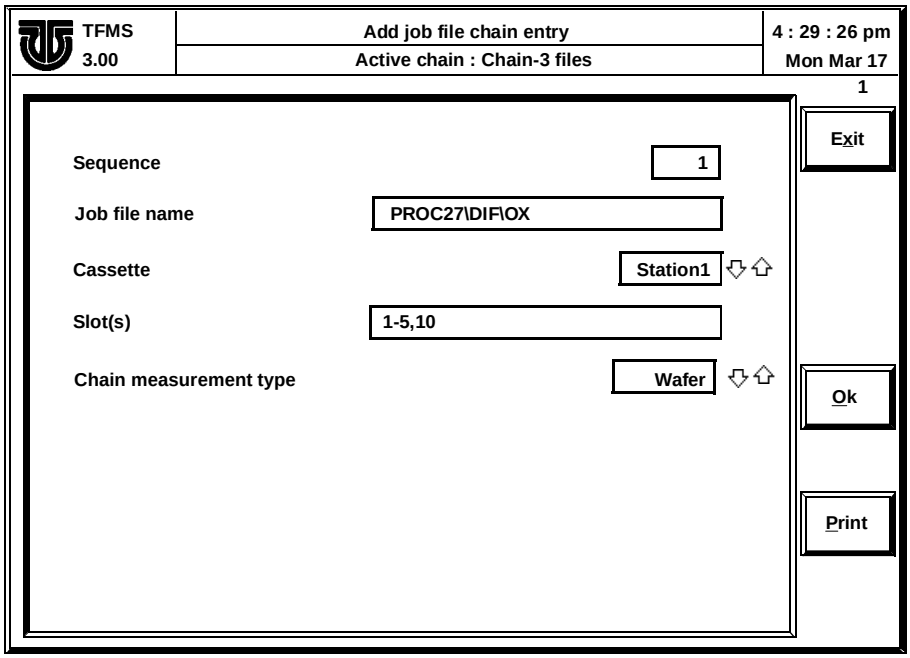
Figure 3.149 Chain measurement type pop-up menu



After you make your selection and select the *Ok* button, the Modify job file chain entry window displays the chain measurement type next to the appropriate job file's *Slot* field, as shown in Figure 3.151.

After you enter information for the first job file, the Add job file chain entry window should look similar to the example shown in Figure 3.150.

Figure 3.150 Add job file chain entry window (after entering information for the first job file)



Ok button: Saves all your entries. If you want to retain your new entries, always select the *Ok* button before selecting the *Exit* button.

After you add the first job file to your job file chain, you use the Add operation to select the next job files and enter the required information for each of them. After adding all the job files in the chain, the Modify job file entry window displays the job files along with their respective cassette station and slot numbers. The example in Figure 3.151 shows the Modify job file entry window with three job files in the chain.

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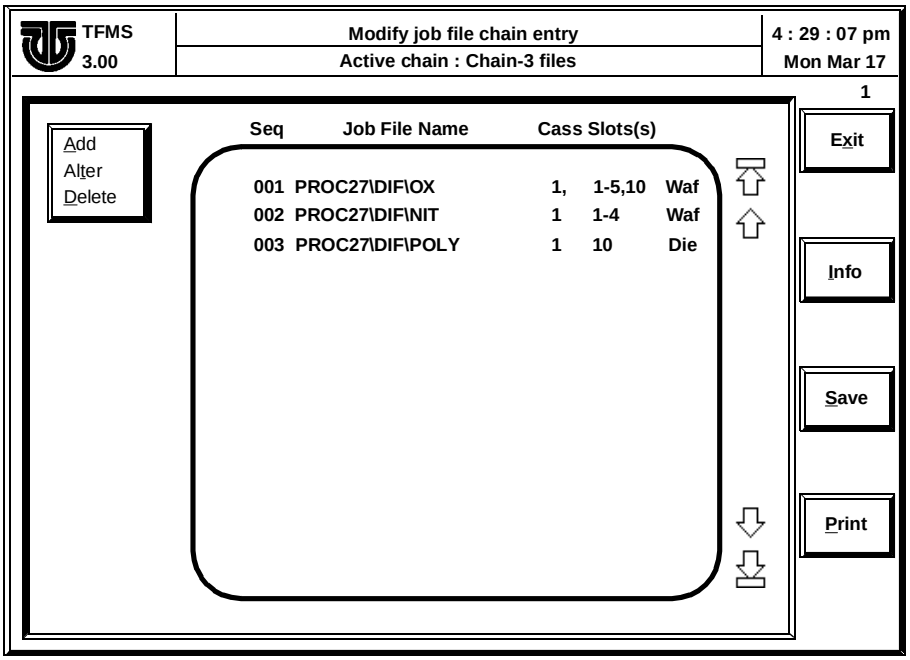
Figure 3.151 Modify job file chain entry window (after creating the job file chain)



When you run a job file chain, the system performs measurements in the order of increasing slot numbers, independent of the job file sequence. If you set up job files to measure wafers from both cassette stations (same or different diameters), the system measures the wafers on Station 1 first, and then measures the wafers on Station 2.

Alter

When you select an entry in the Modify job file chain entry window and then select *Alter* in the Function menu, the Alter window appears, which looks similar to the Add job file chain entry window shown in Figure 3.150. In this window, you can enter another job file name or modify the cassette and slot information. When you select *Ok* in the Alter window, the Modify job file chain entry window reappears.

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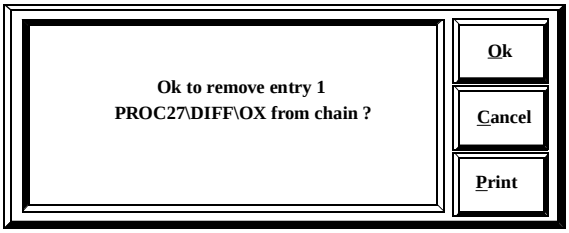
Delete

When you select a job file in the Modify job file chain entry window and then select *Delete* in the Function menu, a confirmation dialog box appears, as shown in Figure 3.152. If you select *Ok*, the system deletes the selected entry.

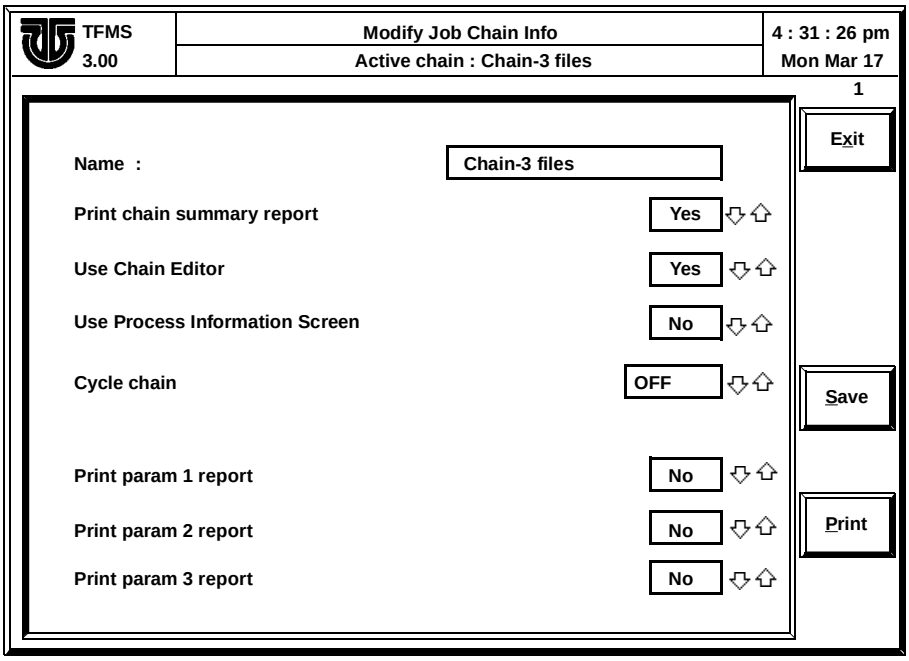
Figure 3.152 Delete dialog box



Info button

When you select the *Info* button in the Modify job file chain entry window, the Modify Job Chain Info window appears, as shown in the example in Figure 3.153. In this window, you can modify the job file chain setup.

Figure 3.153 Modify Job Chain Info window



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Name:Displays the name of the active job file chain. When you select this field, a keyboard window appears where you can enter a new name for the chain.

Print chain summary report:Specifies whether the system prints a Chain summary report after all the wafers are measured. If any of the job files in the chain specify the printing of a Wafer measurement report and/or Cassette summary report, these reports are printed first and the Chain summary report is printed last.

Use Chain Editor, Use Process Information Screen :Specify whether the Chain editor window and/or Process Information window appear at run time. If you repeat (cycle) the job file chain more than once and you specify the appearance of these windows, they only appear at the beginning of the first cycle. For more information on cycling, see Cycle job file chain on the next page.

Cycle chain:Specifies the number of times you'd like to repeat the job file chain. When you select the *Cycle chain* field, three options appear in a pop-up menu, *Off*, *Limited*, and *Forever.*

- *Off* turns the job file chain cycle off. The system only runs the chain once.
- *Forever* cycles the job file chain until you select the *Halt* button.
- *Limited* cycles the job file chain for a specified number of times. When you select *Limited*, the *Cycle count* field appears in the Modify Job Chain Info window, as shown in Figure 3.154. In this field, you enter the number of times you'd like to cycle the job file chain.

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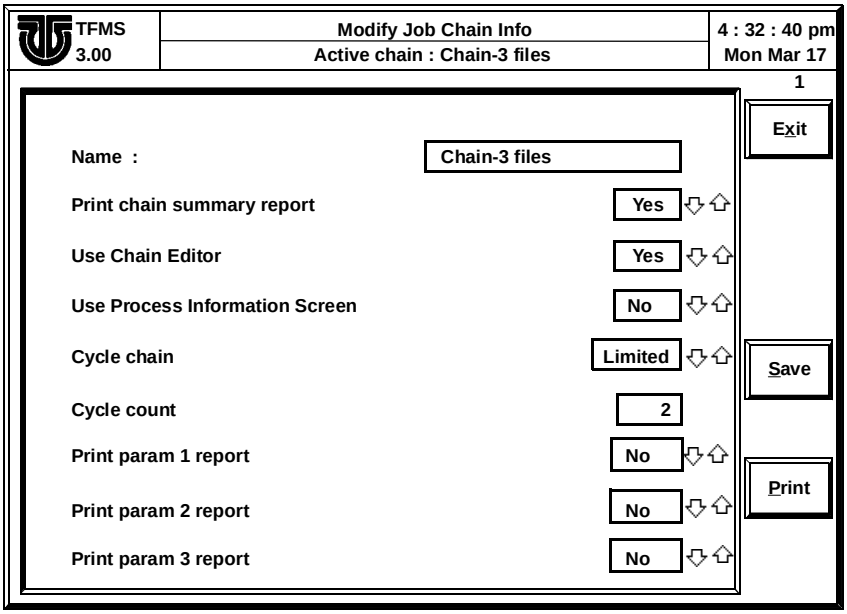
Figure 3.154 Modify Job Chain Info window (after selecting *Limited* in the *Cycle job file chain* field)



For fully automated measurements with no interruptions during the first cycle (*Limited* or *Forever*), select *No* in the *Use Chain Editor* and *Use Process Information Screen* fields. If you want to enter wafer id's, use the Cassette editor in the Main menu before running the job file chain.

You can stop the run in all of the above cases by selecting the *Halt* button.

Print param 1, 2, 3 report(s): Specifies whether the system prints a detailed report(s) for the corresponding parameter(s) after all measurements are completed and any other reports are printed.

When you run a job file chain measurement, the system saves data and displays and prints the measurement results and reports according to your entries in each

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job file's Output control window. After the measurement, the system prints a Job File Chain Report, as specified in the Job File Chain Info window.

After you create a job file chain, it is open and it appears as the active chain in the Status area. At this point, you can run measurements using your new chain. You must always open a job file chain before you can use it to run measurements. The system saves your job file chain in the Job file chain library. When you select *Open file* in the Main menu or *Setup\File\Open*, a *Chain* button appears in the Open file window. If you select this button, the Select a job file chain window appears with a list of all the job file chains, as shown earlier in Figure 3.121. You can also open this window by selecting *Setup\Chain\Open chain*.

3.9.5 Delete

When you select *Setup*/*Chain*/*Delete*, the Delete a job file chain window appears, displaying all the current job file chains. This window looks similar to the Select a job file chain window in Figure 3.121. In this window, when you select a job file chain, the system deletes it from the current list (if you have deletion privileges for that chain).

When an active job file chain is open, you can open the Job file chain summary window and look at the information for that chain by selecting *Display/Chain/Display*. You can print that information by selecting *Display/Chain/Print*.

If you want to access data saved during a job file chain measurement, you must open the job file that was used to obtain the data.

If you select the *Exit* button before saving your entries in the Modify job file chain entry window, a dialog box appears with a reminder message.

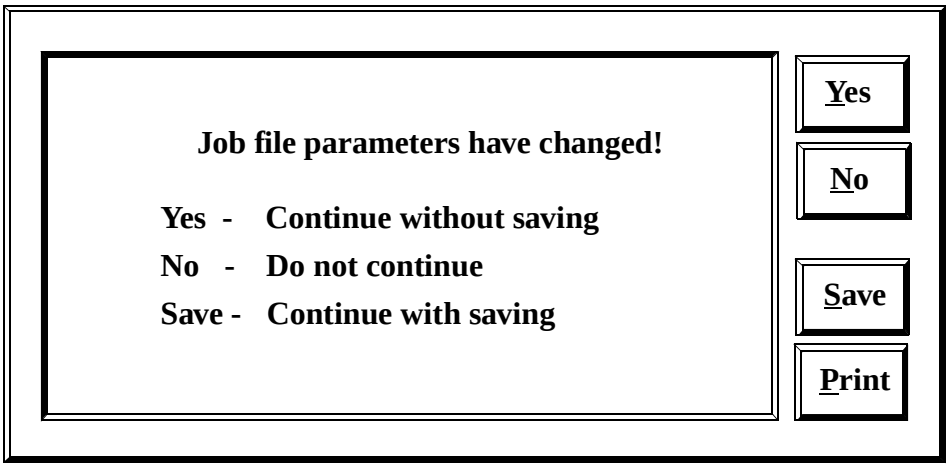
3.9.6 Logging out

When you're finished using the Engineer functions, select the *Exit* button to return to the Main Menu window, and then select the *Logout* button. This returns the system to the Operator level and secures it against unauthorized use. If you do not

have change privileges for the job file, the system closes the job file and logs you out.

If you have change privileges for the job file and did not change any parameters during the current login, the system logs you out. If you have change privileges for the job file and did change any parameters, a dialog box appears with a warning message, as shown in Figure 3.151. Select *Yes* to continue without saving your changes, *No* to cancel the Logout, or *Save* to save your changes. If you select *Yes* or *Save*, the system logs you out accordingly and either closes the job file or keeps it open, as specified by the System parameters. If a job file remains open with unsaved changes, none of these changes are saved when a user opens another job file.

Figure 3.155 Job file parameters changed dialog box



4

PATTERN RECOGNITION FUNCTIONS

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This section describes the Opti-Probe's pattern recognition functions. To use these functions, your system must have a vision processor (VP), and you'll need an Engineer or higher level User ID to configure the job file specific vision processing parameters.

The Introduction to this manual lists the model numbers for all systems that have VP's. Throughout this section, the term VP refers only to the vision processor hardware, VP system refers to both the vision processing hardware and software, and System refers to all of the Opti-Probe's hardware and software.

This section provides you with the following information:

- An overview of typical wafer measurement tasks that utilize pattern recognition
- A summary of vision processing and related functions
- An introduction to pattern recognition terminology
- A detailed description of all the vision processing related menus, windows, and fields
- A pattern recognition troubleshooting guide

Before you begin this section, you should know how to perform engineer level tasks on the Opti-Probe. If you don't know how to perform such tasks, refer to Section 3, "Engineer Functions" and your "Getting Started" manual.

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4.1 OVERVIEW

You use the Opti-Probe's pattern recognition functions to create accurate and repeatable measurement sites on patterned wafers. The center and flat find operation (CFF) finds the center of a wafer and the flat (or notch) at the wafer's edge. In addition, CFF aligns the Y coordinates according to the flat (or notch) position. You must always "fine tune" this coarse alignment using the wafer's pattern. This fine correction uses the Opti-Probe's VP and is called mask alignment. You perform mask alignment (in low magnification) by teaching the VP a distinctive feature (mask model) in the wafer's pattern. The VP searches for a similar pattern at two other locations and aligns the wafer accordingly. After performing mask alignment, you teach the VP system the measurement site coordinates (in high magnification) relative to the center of the wafer (found in CFF) and to its Y alignment (performed in low magnification). If the measurement sites are large and the exact repeatability of measurement locations is not required, you only have to teach site coordinates. If the measurement sites are small and/or the exact repeatability of measurement locations is important, you must also teach the VP a distinctive pattern (site model) near each measurement site and the X,Y offset (stage distance) between the pattern and the measurement site.

4.2 VISION PROCESSING FUNCTIONS

On the Opti-Probe, you can teach measurement site locations using the *Setup*/*Recipe*/*Custom template* and *Die template* options. Following is a summary of the vision processing and related functions, which are described in detail, later in this section:

CFF (center and flat find)

CFF performs a coarse alignment of a wafer by locating its center and determining the major flat or notch orientation. CFF does not require a VP system.

The system must perform CFF before you can teach mask alignment sites. CFF must also be performed prior to mask alignment. If CFF fails, neither of these other operations can proceed.

Mask teach

Mask teach is a semi-automated procedure for defining three alignment sites to provide accurate alignment relative to the pattern (mask alignment). The three sites are defined as follows:

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- Alignment site 1 - distinctive pattern (mask model) selected by the user
- Alignment sites 2 and 3 - semi-automatically learned by the VP system

The three mask alignment sites form a vertical line. Sites 1 and 2 are located near the center of the wafer, while site 3 is located near the top edge of the wafer. During Mask teach, you should position site 1 within 20 mm of the center of the wafer because this location is the least affected by any residual CFF error. You specify the minimum distance where the VP should start searching for Site 2. Site 2 should be close to site 1, typically one die away and also within 20 mm of the center, so that any residual CFF theta (wafer rotation angle) error does not remove site 2 from the field of view. Site 3 should be as far as possible from site 1, or close to the edge of the wafer. This ensures that mask alignment obtains the most accurate theta correction.

Mask align

Mask align automatically performs a wafer alignment using the mask model learned during the Mask teach operation. Because mask alignment positions the stages using an actual pattern on the wafer, it can make corrections for a mask shift. However, if process variation changes the wafer image so much that it no longer resembles the original model, mask alignment performance can be degraded and a new Mask teach operation may be required.

The mask alignment process uses the three alignment sites learned during the Mask teach operation. The vision processor uses sites 1 and 2 to determine the rotation angle of the theta stage for a coarse wafer correction. In addition, it uses sites 1 and 3 for a fine theta software correction.

At the end of a Mask teach or Mask align operation, the wafer is always aligned.

Site teach

Site teach establishes the locations of the measurement sites, the patterns of the site models, if any, and the offsets between the measurement sites and the site models, if any.

Site refers to the measurement location. Model refers to the area on the wafer where the VP learns a distinctive pattern that is associated with the site. Offset is the stage distance in X and Y between the site location and the model location.

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Mask evaluate, Site evaluate

Mask evaluate and Site evaluate allow you to test patterns on a wafer as potential models for the mask teach or site teach operations. In addition, you can use these two evaluation options as diagnostic tools to help you solve pattern recognition problems.

Site visit

Site visit allows you to display all the measurement sites (defined during the Site teach operation) on the sample viewing monitor. If any site models are defined, the Site visit operation searches for the models before applying the site offsets and displaying the sites. You can use this function to test the sites on a wafer and the performance of the VP.

All of the above operations are described in detail, later in this section.

4.2.1 Pattern recognition terminology

Following are some important pattern recognition terms that are used throughout this manual.

Field of view

The area of a wafer that appears on the sample viewing monitor in either high or low magnification. You can change the field of view by moving the wafer with the trackball.

Vision box

A box with crosshairs that appears in the center of the field of view on the sample viewing monitor. The laser spot is at the center of this box.

Train

An action that you perform by selecting a unique pattern in the field of view and instructing the VP to save it as a digital image. This pattern is called a model.

Gray levels

The colors used to display the wafer image in VP mode. The VP system converts the actual colored image to 256 levels of gray. They range from 1 (black) to 256 (white).

Model

A unique pattern in the field of view that you train, and which the VP saves as a digital image. The VP uses a model's pixel to gray level correspondence as a reference when it searches for identical patterns on the same or different wafers. To define a model, you select a distinctive pattern on a wafer by moving it into the vision box with the trackball

Search

An action that you perform by instructing the VP to find a pattern on a wafer that matches a previously trained model. When the VP locates this pattern, it appears in the vision box on the sample viewing monitor.

Teach

An action that you perform to define measurement site coordinates (and, occasionally, site coordinates and an associated model).

Histogram

A distribution of gray levels displayed in a graph. On the Opti-Probe, this graph displays the number of pixels for each gray level in the field of view or in the vision box. An ideal pattern recognition histogram ranges from 32 to 224 levels of gray.

Contrast

The standard deviation of a histogram. An image with a high contrast has a wide distribution of gray levels. A model must have a contrast Š 12 to be acceptable. A contrast >20 is recommended.

Gain and Offset

Parameters that control an image's contrast (gain) and overall darkness or brightness (offset). The offset controls the centering of the histogram in the 1-256 range.

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AGO

The automatic gain and offset parameter that optimizes the distribution of gray levels in the field of view or in the vision box. If you select AGO for the field of view or the vision box, the histogram displays the distribution of gray levels for the corresponding area.

Shape score (resemblance)

An evaluation of the similarity between a pattern and a trained model. The VP grades the shape score between 0 and 1000. This grade is 10 x the percentage of pixels in the vision box that are located at same position and have the same distribution of gray levels as the trained model (with some tolerance). You select the minimum acceptable shape score.

Confidence (unicity)

A definition of how unique a pattern is in the field of view. Confidence = 1000 x (best shape score-next best)/best shape score. You select the minimum acceptable confidence.

Edge enhancement

A number of options that enhance the edges (shape) of wafer patterns and blend the colors. This is useful for patterns that vary in color (and gray levels) from site to site on a wafer or from wafer to wafer.

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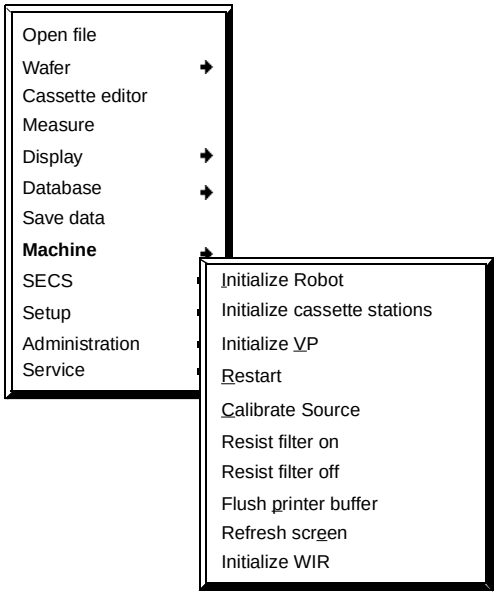
4.3 MACHINE MENU

When you select *Machine* in the Main menu, the Machine menu appears, as shown in Figure 4.1. This menu contains one pattern recognition option, *Initialize VP.*

Figure 4.1 Machine menu (Engineer level)



4.3.1 Initialize VP

Boots and initializes the VP. You use this function when you're experiencing errors resulting from communication problems with the VP.

4.4 RECIPE MENU

When you select *Setup*/*Recipe* on a VP system, *Vision* is selectable, as shown in Figure 4.2. This option provides access to the VP parameter windows where you can configure different types of pattern recognition operations, as described later in this section. The *Custom template* and *Die template* options are only selectable after you open a job file and select *Template* as the measurement type and *Custom*

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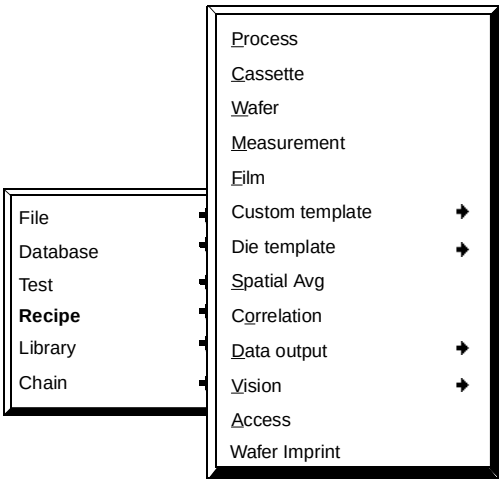
template or *Die template* as the template type in the Measurement Setup parameters window.

Figure 4.2 Recipe menu



If you want the VP to perform mask alignment each time you load a wafer (after teaching mask alignment sites), follow these steps:

1. Select *Setup*/*Recipe*/*Wafer* .

   The Wafer control parameters window appears.

2. Select *Yes* in the *Center flat find?* field.

   The *Perform Mask alignment?* field appears. If you disable CFF this field does not appear.

3. Select *Yes* in the *Perform Mask alignment?* field.

   The *Spiral search?* field appears. If you disable mask alignment, this field does not appear, and the VP does not perform mask alignment during wafer loading.

   The spiral search operation moves the stages in a spiral pattern during mask alignment when mask alignment sites are not visible in the field of view. This operation searches neighboring fields of view covering an area equal to about three times the field of view (Therma-Wave can increase it to 8 times the field

of view). If you want the VP to perform a spiral search (when required) during the mask alignment operation follow step 4:

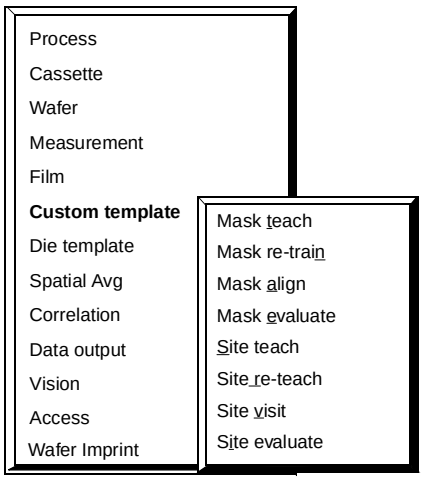
4. Select *Yes* in the *Spiral search?* field.

   If you select *No*, the VP does not search the neighboring fields of view for mask alignment sites.

4.5 CUSTOM TEMPLATE MENU

After configuring your job file's measurement setup for a custom template (as described on the previous page), you can select *Setup*/*Recipe* /*Custom template* . When you select this option, the Custom template menu appears, as shown in Figure 4.3. The options in this menu represent eight functions used with custom template measurements, which are all selectable on VP-equipped systems. The mask related options and *Site visit* and *Site evaluate* operate identically to their corresponding Die template menu options. The Die template menu appears later in this section.

Figure 4.3 Custom template menu



4.5.1 Mask teach

This function allows you to set up three mask alignment sites. When you load a wafer, and select *Mask teach* in the Custom template menu, the Teach Mask Alignment Sites window appears, as shown in Figure 4.4. The wafer is pre-aligned

if *CFF =Yes* in *Setup*/*Recipe*/*Wafer*. If *CFF* is not enabled, the system aligns the wafer, and then opens the window.

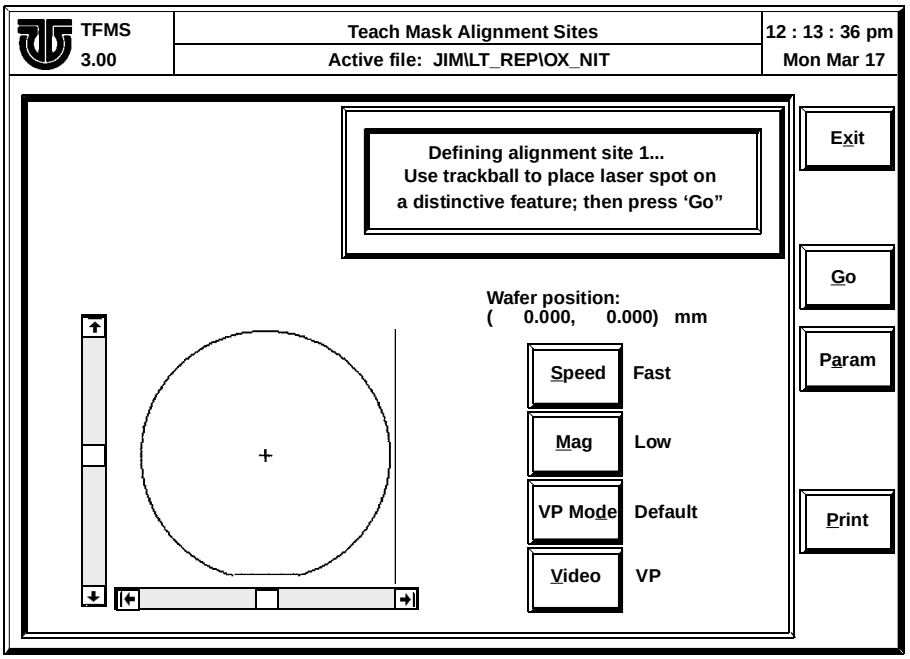
When you enter this window, the system automatically switches to low magnification, moves to the center of the wafer, and displays this area with the vision box on the sample viewing monitor. **Do not** change to high magnification.

The *VP Mode* , *Video* , and *Param* buttons perform pattern recognition related functions (explained later), while the *Speed* (trackball response) and *Mag* (lens magnification) buttons perform their usual functions.

The instructions at the top of this window say: *Defining alignment site 1... Use trackball to place laser spot on a distinctive feature; then press "Go".*

For site 1, find a distinctive feature approximately 20 mm from the center of the wafer, and then select the *Go* button.

Figure 4.4 Teach Mask Alignment Sites window



When you select the *Go* button, the VP learns the first alignment site (i.e., saves the image) and then the stage moves up by the default distance between Site 1 and Site 2 (specified in the Mask teach VP parameters window, shown later in Figure 4.5). If the VP does not find the same pattern at that location, the stage moves up in

0.7mm increments until the same pattern is found, which becomes Site 2. Site 2 is usually one die apart from Site 1 (approximately 20 mm from the center of the wafer). The system performs a rotation adjustment, and then returns to Site 1 for a relearn. Next, the VP uses the new distance between Site 1 and Site 2 to calculate a Site 3 location that is closest to the edge of the wafer, but not within the edge exclusion distance specified in the Mask teach VP parameters window. After finding Site 3, the VP system applies a software correction to all the coordinates on the wafer.

If the searching process succeeds, a brief Status line message says, *Wafer successfully aligned...* and then the Mask teach confirmation dialog box tells you to select the *Save* button to save your sites.You must select the *Save* button in this dialog box if you want to save your mask alignment Sites. If the VP cannot find Site 1, it automatically optimizes the brightness and contrast and then attempts to find the Site. If the VP recognizes Site 1 but not Sites 2 and 3, or finds Sites 1 and 2 but not Site 3, it automatically retrains Site 1 and then searches for the other Site(s).

Neighboring field of view search (optional)

If your System Manager configured the diagnostics setup to search the neighboring fields of view during the mask teach operation, the VP positions your model at each of the four corners of the field of view, searching for another pattern that is similar to your model. If the VP does not find a similar pattern, this verifies that the mask model is still unique in the field of view. If the VP finds a similar pattern, a message informs you that the model is not unique. If this message appears, you should modify the mask teach parameters and repeat the teach operation or teach a new model. For more information on the System Manager setup, see *Main Menu*/*Administration*/*Diagnostics* in Section 7, "System Manager Functions."

Go button

Initiates the teaching sequence. You select this button after selecting a distinctive pattern for Site 1 and selecting the Mask teach parameters described below.

VP Mode button

This button also appears in the Mask evaluate, Site teach (Teach Measurement Sites), and Site evaluate windows for custom templates, and in the Dice and sites (Edit Sites) window for Die templates. The following information applies to all of the above operations.

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The *VP Mode* button toggles between five options: *Default*, *Edge 1*, *Edge 2*, *Edge3*, and *Custom.* These options control VP edge enhancement pre-processing of the sample image. Because edge enhancement slows the pattern recognition operation, you should only use it when low contrast and very few features appear in the field of view or if normal gray-scale pattern recognition (default mode) fails. The VP system keeps track of whether a model was trained with edge enhancement and uses that setting during search operations.

Following is a description of the four VP mode options:

Default :Applies the Opti-Probe's default pattern recognition parameters (normal gray scale). These default parameters do not utilize edge enhancement.

You select *Edge1* or *Edge2* to apply image processing when the colors/shades of gray of a feature vary within the same wafer or from wafer to wafer, or when the contrast is too low.

Edge1 :Enhances the edges of a feature with moderate contrast, displaying them in dark gray on the sample viewing monitor.

Edge2 :Enhances the edges of a feature with higher contrast than *Edge1*, displaying them darker and wider on the sample viewing monitor.

Edge3:Enhances the X and Y directional edge features, and greatly reduces any background noise. This option is very useful for ultra-low contrast wafers.

Custom :Applies the custom image processing parameters entered in the Custom Image Processing Parameters window shown in Figure 4.65, later in this section.

Video button

Selects the video display mode for the sample viewing monitor. Following is a description of the three video options:

Live :Normal view using color camera.

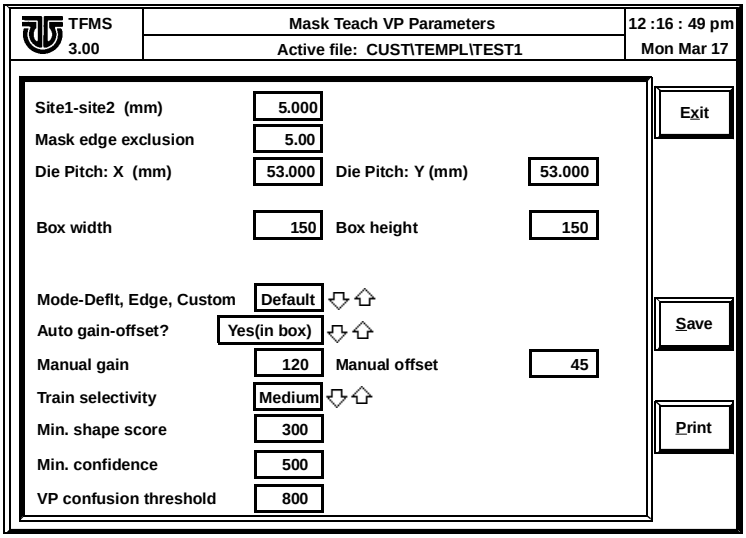
VP:Displays a gray scale image with a vision box at the center of the field of view. The pattern recognition system uses this display mode, which is useful when you'd like to preview the exact portion of the VP's field of view during the training sequence.

Meas area : Displays the wafer's measurement area (used in spatial averaging) and scales this area to the magnification. In addition, this option also displays the measurable area for the spectrometer.

Param button

Opens the Mask Teach VP Parameters window, as shown in the example in Figure 4.5. In this window, you can customize the pattern recognition parameters that are used for mask alignment. Some of these parameters also appear in the Site Teach VP Parameters window and are used for Site alignment, as described later in this section.

Figure 4.5 Mask Teach VP Parameters window



Site1 - site2 (mm)

Used to teach mask alignment site 2. After you identify the first site, the vision processor system searches for sites 2 and 3. This parameter specifies the vertical (Y) distance from site 1 to where the system begins searching for site 2.

If you enter your wafer's Y die pitch in this field, the desired site 2 pattern immediately appears in the VP's field of view during a search operation. In addition, whenever possible, sites 1 and 2 should both be within 20 mm of the center of the wafer.

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Mask edge exclusion

Specifies the minimum distance between site 3 and the edge of the wafer.

Die Pitch: X (mm), Die Pitch: Y (mm)

Specify the X and Y die dimensions in millimeters. These are "repeat" dimensions, so they include the scribe lines in addition to the die. After you teach the horizontal and vertical pitch for a Die template setup, or enter X and Y die pitch values in the Wafer control parameters window for a custom template setup, the system automatically enters the corresponding values in these fields.

Box width, Box height

Specify the width and height, in pixels, of the pattern stored during Mask teach, and searched for during mask alignment. Generally, in low magnification with the sample viewing monitor in VP video mode, the system displays a white box and cross hairs with this width and height. This is the vision box. Typical box dimensions are 150 pixels, while the vision processor's field of view is 576 x 448 pixels. Always configure a vision box size that is approximately the same size as the feature you're attempting to align on. In order for the VP to find a match, the entire stored pattern (i.e., the entire area outlined by the box) must appear in the field of view on the sample viewing monitor. If the box is too large, the entire pattern may not be in the field of view during the alignment operations.

You can use different box size parameters for mask alignment and site alignment. You specify the site alignment box size parameters in the Site Teach VP parameters window, described later in this section.

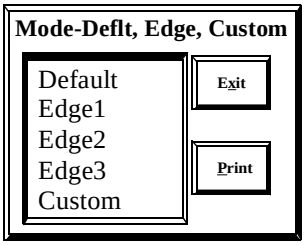
Mode-Deflt, Edge, Custom
[also applies to Site teach, later in this section]

Specifies the vision processing mode. When you select this field, the Mode-Deflt, Edge, Custom pop-up menu appears with five pattern recognition options, as shown in Figure 4.6. When you select one of these options, it is the same as toggling the VP Mode button in the Teach Mask Alignment Sites window, described earlier in this section.

Default

Applies the Opti-Probe's default pattern recognition parameters with normal gray level distribution and no image processing (edge enhancement).

Figure 4.6 Mode-Deflt, Edge, Custom pop-up menu



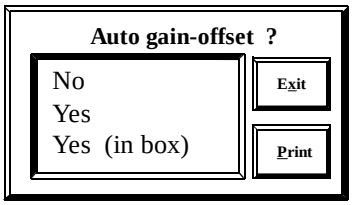
Edge1, Edge2, Edge3: Applies image processing that enhances the edges of features. You should use this option for low contrast patterns or when the colors/shades of gray of a feature vary within the same wafer or from wafer to wafer. *Edge1* enhances the edges of a feature with moderate contrast, displaying them in dark gray on the sample viewing monitor. *Edge2* enhances the edges of a feature with higher contrast than *Edge1*, displaying them darker and wider on the sample viewing monitor. *Edge3* enhances the X and Y directional edge features, and greatly reduces any background noise. This option is very useful for ultra-low contrast wafers.

Custom : Applies the custom image processing parameters entered in the Custom Image Processing Parameters window, shown later in this document.

Auto gain-offset? (AGO) [also applies to Site teach, later in this section]

Optimizes the brightness and contrast of an image so the VP can be trained and consistently find the pattern. When you select this field, the Auto-gain offset pop-up menu appears with three options, as shown in Figure 4.7. You can optimize the brightness and contrast by selecting one of these gain and offset options.

Figure 4.7 Auto gain- offset pop-up menu



No : Disables AGO and uses the Manual gain and Manual offset values instead.

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Yes :Optimizes the brightness and contrast in the entire field of view. This can maximize the contrast and maintain a gray level distribution centered between 32-224, preventing saturation. You should use this option when the pattern within the box has the same range of gray levels as the rest of the field of view.

Yes in box :Optimizes the brightness and contrast for the pixels in the vision box. You should select this option when the pattern within the vision box uses a different range of gray levels than the rest of the field of view.

Manual gain [also applies to Site teach, later in this section]

Affects the image contrast. An increase in gain decreases the image contrast, while a decrease in gain increases it. You should adjust this parameter in increments of 10 (approximately). For instructions on correcting low contrast, see the "Optimizing the gain and offset" tutorial in your "Getting Started" manual.

Manual offset [also applies to Site teach, later in this section]

Affects the image brightness. An increase in the offset decreases the image brightness, while a decrease in offset increases it. A unit of offset corresponds to 1 bin on a histogram. For instructions on correcting low contrast, see the "Optimizing the gain and offset" tutorial in your "Getting Started" manual.

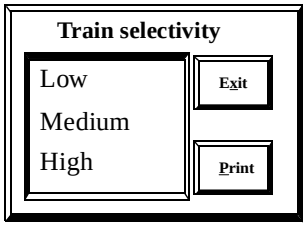
You use Manual gain and Manual offset during the train and search operations when AGO is disabled. The values you select affect the appearance of the field of view.

Train selectivity [also applies to Site teach, later in this section]

Specifies the degree of selectivity that the VP uses during the training operation, providing settings for the minimum shape score and minimum confidence. During the search (*Mask align*) operation, the VP uses the separate parameters that you enter at the bottom of the Mask Teach VP Parameters window for the minimum shape score and minimum confidence. When you select this field, the Train selectivity pop-up menu appears with three options, as shown in Figure 4.8.

Low :Specifies a low degree of selectivity for patterns with poor repeatability (e.g., lower minimum shape score [see below] for acceptance of site 3 when gray levels are not identical to sites 1 and 2).

Figure 4.8 Train selectivity pop-up menu



Medium: Specifies a medium degree of selectivity for patterns with average repeatability.

High :Specifies a high degree of selectivity for patterns with excellent repeatability.

Min. shape score [also applies to Site teach, later in this section]

Specifies the minimum shape score the system accepts when the VP searches for a mask alignment image in low magnification. The shape score indicates how accurately a feature in the field of view correlates with a stored model. A score of 0 indicates no correlation, while 1000 indicates perfect correlation.

Min. confidence [also applies to Site teach, later in this section]

Specifies the minimum confidence the system accepts when the VP searches for a mask alignment image in low magnification. Confidence is defined as 1000 (S1-S2)/S1, where S1 is the highest shape score and S2 is the second highest shape score. The maximum possible confidence is 1000, which occurs if there is only one candidate feature; this is equivalent to S2=0. The lowest possible confidence is 0, which occurs if S1=S2. A typical value for the minimum confidence is 500, which is found when the next best shape score is half the best shape score.

VP confusion threshold [also applies to Site teach, later in this section]

Specifies the confusion threshold used by the VP when it searches for a mask alignment image in low magnification. During the search process, if the VP finds a feature with a shape score that exceeds the confusion threshold, it accepts the feature as a match and stops searching. If the VP does not find a feature with a shape score exceeding the confusion threshold, it searches the entire field of view and accepts the candidate with the best shape score as a match. Consequently, the confusion threshold can provide a trade-off between the speed and the accuracy of

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model-feature matching. A low confusion threshold (e.g., 500) results in faster search times but a greater probability of false accepts (incorrect matches). A high confusion threshold (e.g., 1000) results in slower search times but ensures that the candidate with the highest shape score in the entire field of view is selected as a match.

4.5.2 Mask re-train

This option allows you to update a mask model without re-teaching the site coordinates. This is helpful when a process changes over time and the site pattern no longer resembles the original model. The VP system optimizes the gray levels on the same model at the same location on a different wafer so it can recognize that model (good confidence and shape score).

When you select *Mask re-train*, the Teach Mask Alignment Sites window appears (see Figure 4.4), and then the VP system automatically positions the vision box on mask alignment site 1 and retrains this model, optimizing its gray levels. During this operation, you see the following messages appear in sequence: *Performing mask model retrain*, *Retraining model at site 1*, *Performing mask alignment....please wait*.

If the mask re-train is successful, the following information is displayed in the Mask re-train window: *Mask Re-Train succeeded, No need to re-teach mask site coord. via Mask Teach, To save mask information to job file, select Save.* If you select the *Exit* button without saving, the system cancels the re-train operation.

If the mask re-train operation fails, a dialog box recommends that you perform a mask teach operation. If you select *Ok*, you return to the Teach Mask Alignment Sites window.

In this window, you can select a new mask model. You can also select the *Param* button and modify the mask teach parameters (e.g. *Train selectivity, AGO*), as described earlier in this section. If you select the *Cancel* button, you return to the Main Menu window without modifying your mask model.

4.5.3 Mask align

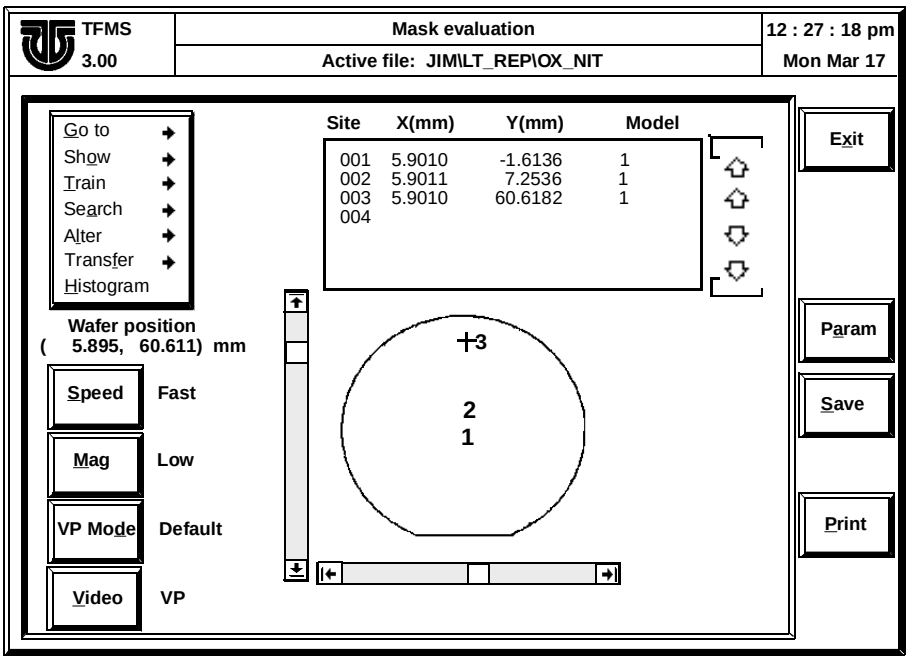
When you select Mask align in the Custom template menu, the system performs a mask alignment using the three alignment sites previously defined during a Mask teach operation. The system performs this operation each time you load a wafer. The sequence of steps is similar to Mask teach, but the VP searches for the previously defined model at the alignment sites instead of learning it from the user.

If the mask alignment succeeds, a confirmation message briefly appears in the Status line (same message as Mask teach). If it is unsuccessful, the alignment process stops and an error message appears.

4.5.4 Mask evaluate

When you select *Mask evaluate* in the Custom template menu, the Mask evaluation window appears, as shown in Figure 4.9. In this window, you can evaluate wafer features as potential mask alignment models and compare wafer images to a stored model image. You can use this information to diagnose mask alignment problems or verify that the stored model is satisfactory. When you open this window, the system automatically switches to low magnification. **Do not** change to high magnification. You can perform similar operations in high magnification in the Site evaluation window, described later in this section.

Figure 4.9 Mask evaluation window



In this window, you see a Site list at the upper right side, a Stage locator at the bottom and a Function menu in the upper left corner. You also see a *Param* button in the window's right margin. If a wafer is not loaded, only the *Alter* Function is selectable in the Function menu.

Site list

If you open this window before performing a successful Mask teach operation, the Site list only displays an empty site 001, and the wafer shape is blank (except for the cross hair). If you open this window after performing a successful Mask teach operation, it looks similar to the example in Figure 4.9 and the Site list displays the three mask alignment sites stored during Mask teach. The site numbers also appear in the wafer shape. All three sites have the same vision model, generally Model 1. If "Edge" appears next to the model number, it indicates that edge enhancement was enabled during the *Mask teach* operation.

Stage locator

You can use the Stage locator's scroll bars and buttons to move the stages in die size units set up in the Wafer control parameters window (see Section 3), or the Mask Teach VP Parameters window (described earlier in this section). You can use the Video and VP Mode buttons to perform the functions described in the Teach Mask Alignment Sites window, described earlier in this section (Mask teach function). Generally, you should remain in VP video mode when you're working in this window.

Param button

Opens the Mask Teach VP Parameters window, described earlier in this section and shown in Figure 4.5. In this window, you can customize the pattern recognition parameters that are used for mask alignment.

Function menu

The Function menu displays a list of operations you can perform using mask alignment sites ("site" operations) or any area you'd like to test on a wafer ("test" operations, performed on site candidates).

Go to /Site

You can drive the stages to a specific mask alignment site by following these steps:

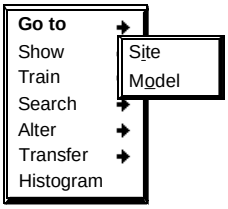
1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

The Go to menu appears with two options, as shown in Figure 4.10.

Figure 4.10 Go to menu



3. Select *Site* in the Go to menu.

   The stages go to the selected site coordinates. The screen blanks briefly while the stages move.

   The sample viewing monitor displays the area near the selected site.

Go to /Model

You can drive the stages to a specific mask alignment site model by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The Go to menu appears with two options, as shown in Figure 4.11.

3. Select *Model* in the Go to menu.

   The stages go to the selected model coordinates. The screen blanks briefly while the stages move.

   The sample viewing monitor displays the area near the selected site model. For a mask, the sites coincide with the models, and *Go to* /*Site* and *Go to* /*Model* perform the same operation.

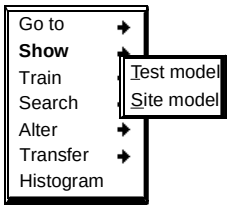
Show /Test model

You can view the stored test model image by following these steps:

1. Select *Show* in the Function menu.

   The Show menu appears with two options, as shown in Figure 4.11.

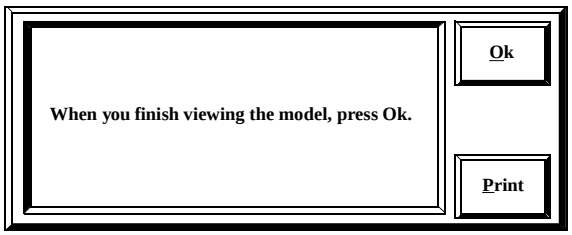
Figure 4.11 Show menu



2. Select *Test model* in the Show menu.

   The VP displays the test model stored during a Train test model operation (described later), which was performed since opening the Mask evaluation window. The sample viewing monitor displays the test model, which only includes the image that was within the vision box at train time. The TFMS monitor displays a dialog box, as shown in Figure 4.12. If the VP does not have a stored test model, you see a dialog box reminding you to train a test model first.

Figure 4.12 Show test model dialog box



3. Select *Ok* in the dialog box.

   You return to the Mask evaluation window, and the sample viewing monitor returns to the previous field of view.

Show /Site model

You can view the stored model image for the mask alignment sites by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Show* in the Function menu.

   The Show menu appears with two options, as shown in Figure 4-8.

3. Select *Site model* in the Show menu.

   The VP displays the site model stored during a previous Mask teach operation. The sample viewing monitor displays the site model, which includes only the image that was within the vision box at train time. The TFMS monitor displays a dialog box, as shown in Figure 4.12.

   If you haven't performed a successful Mask teach operation for the active job file, and you selected the empty site 001 entry, a dialog box appears reminding you what to do. Select *Ok* in the dialog box, and perform a Mask teach operation before re-selecting this option.

4. Select *Ok* in the dialog box.

   You return to the Mask evaluation window, and the sample viewing monitor returns to the previous field of view.

Train /Test model

You can train a test model by following these steps:

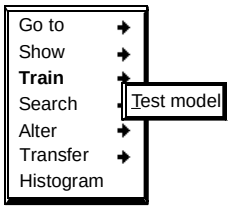
1. Use the stage locator to move to a field of view containing a feature you'd like to evaluate.

   If you're in VP video mode, you see a white box with cross hairs on the sample viewing monitor. This is the vision box, which outlines the region to be learned by the VP. You can change its size in the Mask teach VP parameters window, described later in this section.

2. Select *Train* in the Function menu.

The Train menu appears with one option, as shown in Figure 4.13.

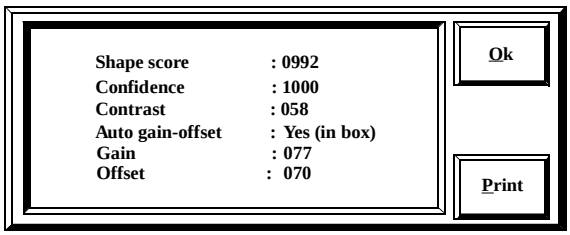
Figure 4.13 Train menu



3. Select *Test model* in the Train menu.

   The VP system converts the image within the vision box to a model representation and saves it. This is the training step. Then the VP system immediately searches the field of view for the image it just trained. If the search is successful, you see a dialog box that displays shape score, confidence, contrast, and gain/offset values, as shown in Figure 4.14. These quantities are explained next under *Search Test model*.

Figure 4.14 Train test model results dialog box



   If the search is unsuccessful, an error message appears. The most common reasons for failure are: a feature that is not unique within the field of view or a low contrast. This indicates that the feature is not a good choice.

4. Select *Ok* in the dialog box.

   You return to the Mask evaluation window.

Search /Test model

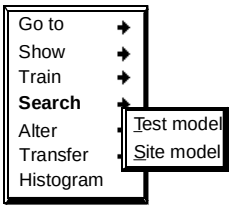
You can search the field of view for a stored test model by following these steps:

1. Use the stage locator to move to the desired field of view to search for your test model.

2. Select *Search* in the Function menu.

   The Search menu appears with two options, as shown in Figure 4.15.

Figure 4.15 Search menu

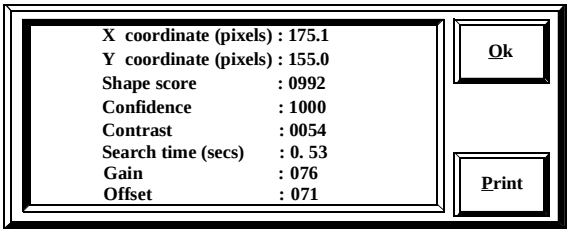


3. Select *Test model* in the Search menu.

   The VP searches the field of view for the last test model trained since opening the Mask evaluation window. If the VP does not find a stored test model, a dialog box reminds you to train a pattern as a test model first. If the search is successful, a dialog box appears that displays several values, as shown in Figure 4.16. The sample viewing monitor displays a black box with cross hairs that outlines the feature that the VP found. This is the vision box. In the lower left corner of the vision box you see a 1 (this is an identifier), and in the lower right corner of the screen you see shape score and confidence results.

Whenever the VP searches for an image model, the entire image must be within the field of view in order for the VP to find it. If you select the *Exit* button in the Mask evaluation window, the system deletes the trained test model.

Figure 4.16 Search/test model results dialog box



If the search is unsuccessful, an error message appears. The most common reasons for failure are: a model is not entirely or not at all present in the field of view, the model is not unique within the field of view, or the feature characteristics are not sufficiently similar to the model. If the feature is not unique, the sample viewing monitor displays two vision boxes that outline the two features with the highest shape scores (best match to the stored model).

4. Select *Ok* in the dialog box.

   You return to the Mask evaluation window.

   The values in the results dialog box are defined as follows:

   X coordinate (pixels), Y coordinate (pixels):Designate the X and Y coordinates of the upper left corner of the vision box outlining the matched feature. X=0, Y=0 designates the upper left corner of the screen, which is 576 pixels wide (X) and 448 pixels high (Y).

   Shape score:Indicates the quality of resemblance between the pattern the VP finds and the model.

   Confidence:Indicates how unique the pattern is in the field of view.

   Contrast:Indicates how much gray scale variation is contained in the field of view.

   Search time (secs):Displays the amount of time it took the VP system to search the field of view and identify the feature.

   Gain and Offset:Control an image's contrast (gain) and overall darkness or brightness (offset).

Search /Site model

You can search the field of view for the stored mask alignment site model by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Use the stage locator to move to the desired field of view to search for your test model.

   Alternatively, you can select *Go to*/*Site* or *Go to*/*Model*.

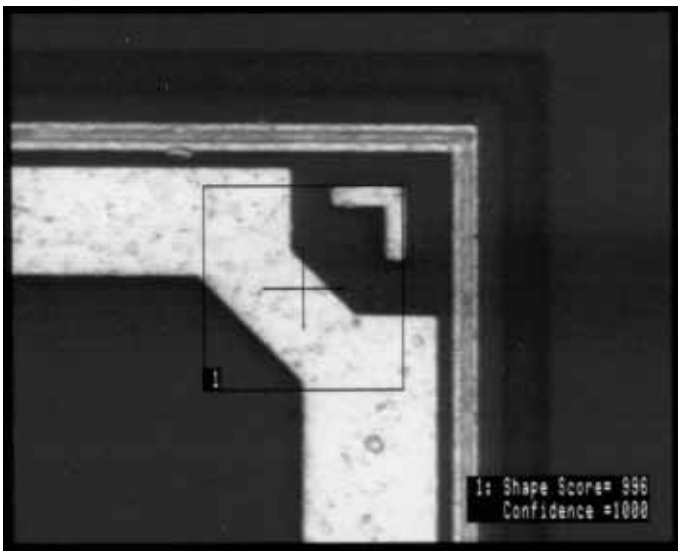
3. Select *Search* in the Function menu.

   The Search menu appears with two options, as shown in Figure 4.12.

4. Select *Site model* in the Search menu.

   The VP searches the field of view for the site model stored during a previous Mask teach operation. On the sample viewing monitor, the vision box outlines the feature that the VP found, as shown in Figure 4.17. In the lower left corner of the vision box you see a 1 (this is an identifier), and in the lower right corner of the screen you see the shape score and confidence results.

Figure 4.17 Search site model



If the search is successful, a dialog box appears that displays several values, as shown in Figure 4.13. The values in the results dialog box are defined earlier in this section, under *Search Test model*.

Whenever the VP searches for an image model, the entire image must be within the field of view in order for the VP to find it. If the search is unsuccessful, an error message appears. If you haven't performed a successful Mask teach operation for the active job file, and you selected the empty site 001 entry, a dialog box appears reminding you what to do. Select *Ok* in the dialog box, and perform a Mask teach operation before re-selecting *Search site model*.

5. 5. Select *Ok* in the results dialog box.

   You return to the Mask evaluation window.

Alter /Stage X/Y

You can alter the coordinates of the three mask alignment sites by selecting the new X,Y coordinates with the trackball or by entering the new X,Y coordinates manually.

To alter a site with the trackball, a wafer must be loaded.

You can use the trackball to alter a mask alignment site by following these steps:

1. Select a site in the Site list with the light pen.

   Your selection turns dark green.

2. Position a measurement site under the laser spot using the trackball.

   The sample viewing monitor displays the area near your measurement site.

3. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*.

4. Select *Stage X/Y* in the Alter menu.

   The new X/Y coordinates appear next to your selected site in the Site list, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Alter /Manual

You should only use this manual option if you know the exact coordinates of the new mask alignment sites. If a wafer is not loaded, you must use this manual option to alter these sites.

You can alter a mask alignment site by manually entering the X, Y coordinates as follows:

1. Select a site in the Site list with the light pen.

   Your selection turns dark green.

2. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*.

3. Select *Manual* in the Alter menu.

   A dialog box appears where you can enter the new X,Y coordinates.

4. Enter the new X,Y coordinates and select *Ok* in the dialog box.

   The three mask alignment sites must have the same X values.

   The new X/Y coordinates appear next to your selected site in the Site list and next to the wafer shape in the Stage locator, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Transfer /Model to flpy

This function allows you to copy a model to a floppy disk (to send to Therma-Wave for diagnostic purposes).

You can copy a model to a floppy disk by following these steps:

1. Select a site with a model in the Site list.

2. Select *Transfer* in the Function menu.

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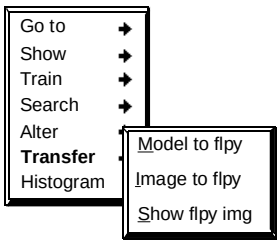
The Transfer menu appears with three options, as shown in Figure 4.18.

Figure 4.18 Transfer menu



3. Select *Model to floppy* in the Transfer menu.

   A dialog box appears that asks you to insert a DOS formatted disk into the floppy disk drive.

4. Follow the directions in the dialog box.

   The system copies the selected site model (image in vision box) to your floppy disk.

Transfer /Image to flpy

You can copy a model's field of view image to a floppy disk by following these steps:

1. Select a site with a model in the Site list.

2. Select *Transfer* /*Image to flpy* in the Transfer menu.

3. Move the trackball to the desired field of view, and insert a DOS formatted disk into the floppy drive.

   The system copies the selected field of view image to your floppy disk.

Transfer /Show flpy img

You can display a model's field of view image that is stored on a floppy disk by following these steps:

1. Select any site model in the Site list.

2. Select *Show flpy img* in the Transfer menu and insert the disk with the desired image into the floppy drive

   The system displays the floppy disk image on the sample viewing monitor.

Histogram

You can use the histogram function to display the distribution of gray scale values in the current (low magnification) field of view or in the vision box on the sample viewing monitor. This function is useful for optimizing the gain and offset used by the VP system for the active job file. You can manually adjust the gain to change the image contrast and manually adjust the offset to change the overall darkness or brightness of the image. Alternatively, you can select the automatic gain and offset mode. These settings are described in the "Optimizing the vision gain and offset" tutorial in your "Getting Started" manual. You can view a histogram for an area (field of view or vision box) on a wafer by following these steps:

1. Use the stage locator to move the stages to a field of view where you'd like to display a histogram.

2. Select the *Param* button

   The Mask Teach VP Parameters window appears.

3. Select *Yes*, *Yes(in box)*, or *No* in the *Auto gain-offset* (AGO) field.

   Yes = automatic optimization of gain and offset (AGO) in the field of view

   Yes in box = AGO in the vision box

   No = use manual gain and offset values in Mask Teach VP parameters window

4. Select *Histogram* in the Function menu.

   After the VP creates the histogram, you see it appear on the sample viewing monitor, as shown in the example in Figure 4.19 with AGO enabled in the field of view. For a complete description of the histogram, see the next page.

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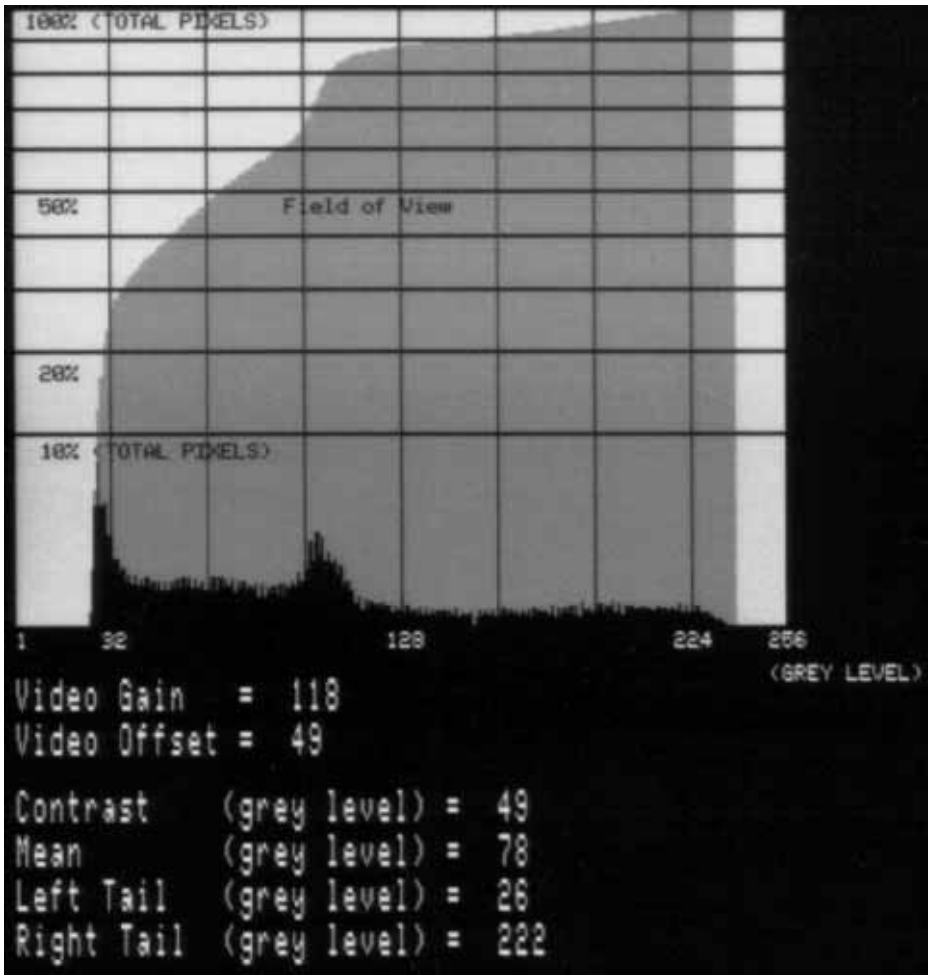
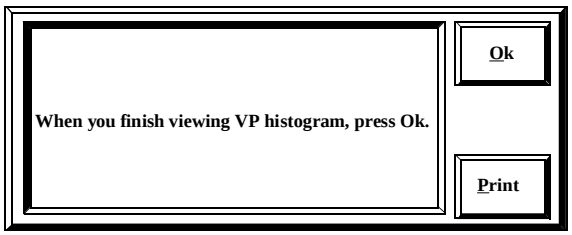
Figure 4.19 Histogram (AGO in field of view)



The TFMS monitor displays a dialog box, as shown in Figure 4.20.

Figure 4.20 Show histogram dialog box



5. Select *Ok* in the dialog box.

   You return to the Mask evaluation window, and the sample viewing monitor returns to the previous field of view.

Following is a description of the histogram display:

In the center of the display you see two histograms plotted on the same axes. Each bin on the horizontal axis represents a specific gray level intensity, where 1 = black and 256 = white. The vertical axis is a pseudo-logarithmic representation of the fraction of total pixels. The black histogram displays the fraction of total pixels that have the given light intensity. The gray histogram is a cumulative display (i.e., displays the fraction of total pixels that have the given intensity or less).

Below the histograms you see a caption listing the following quantities of interest:

Video gain, Video offset: If No is selected for AGO in the Mask Teach VP Parameters window, the histogram displays the manual gain and offset values. If Yes is selected for AGO, the VP system automatically adjusts the gain and offset so all gray levels in the field of view range from 32 to 224 and the histogram displays these values, as shown in Figure 4.16. If *Yes* (*in box*) is selected for AGO, the VP system automatically adjusts the gain and offset so all gray levels in the vision box range from 32 to 224 and the histogram displays these values. For more information on these parameters, see the Mask teach VP parameters window, later in this section.

Contrast: Indicates how much gray scale variation is contained in the field of view. Specifically, the contrast is the standard deviation of the gray scale distribution. A contrast above 20 is good, while the maximum realistic value is about 100. The system does not accept patterns (as models) with a contrast of less than 12.

Mean : Displays the mean gray level of the distribution.

Left Tail, Right Tail: Indicate the gray level for 1% and 99%, respectively, of the total number of pixels (i.e., 1% and 99% points on the cumulative histogram).

4.5.5 Site teach

To use this function, you must select *Template* as the measurement type and *Custom* as the template type in the Measurement Setup parameters window. If you select *Site teach* before making these selections, a message tells you to

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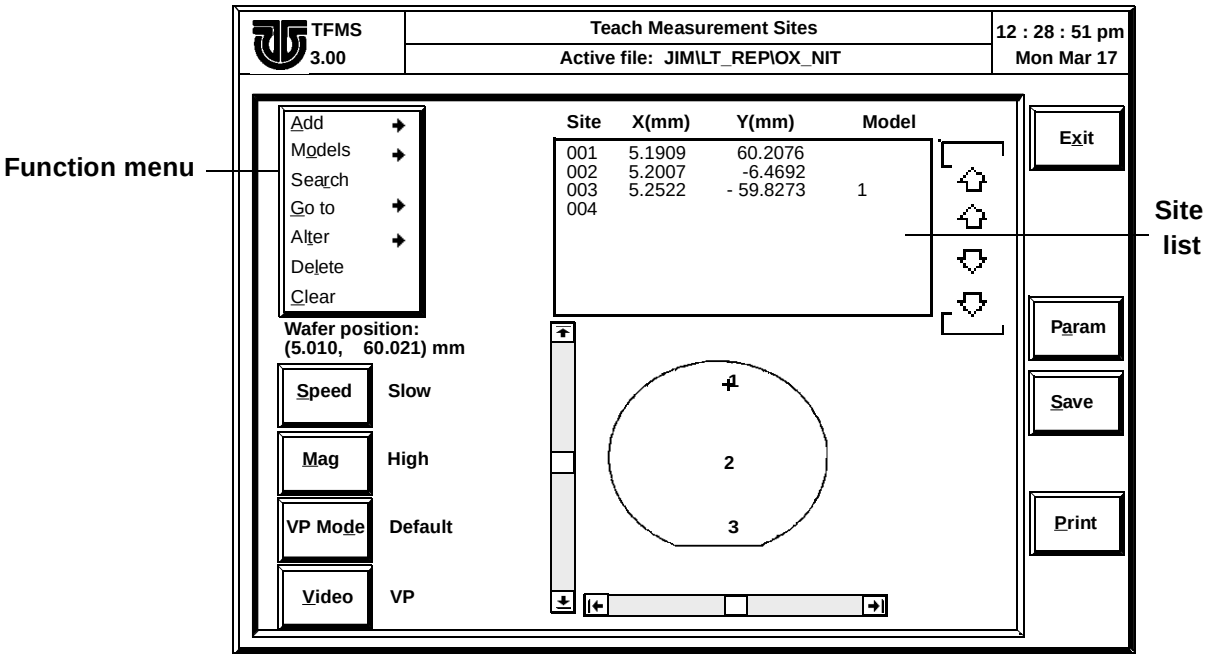
re-configure these parameters. For patterned wafers, you should also load a wafer and perform a Mask teach or Mask align operation before using this function.

When you select *Site teach* in the Custom template menu, the Teach Measurement Sites window appears, as shown in the example in Figure 4.21. In this window, you can define the measurement site coordinates and teach a model for each site (site alignment). You see a Function menu near the top left corner of the window with a Site list next to it, and a *Param* button appears in the right margin. You also see a Stage locator at the bottom of the window with *Speed*, *Mag*, *VP Mode*, and *Video* buttons.

Figure 4.21 Teach Measurement Sites window



When you open this window with a custom template already saved in the job file and a wafer loaded, it looks similar to the example shown in Figure 4.18. The Site list and the wafer shape show the previously taught sites. If a wafer is not loaded, the Stage locator is non-functional, its scroll bars and buttons do not appear, the Function menu's *Models*, *Search*, *Go to*, and *Clear* options are non-selectable, and the message *No wafer loaded* appears below the wafer shape.When you open the window for the first time (before saving a custom template), the Site list only displays an empty site 001 and the wafer shape is empty.

Site list

The Site list displays the measurement site numbers, X, Y coordinates, and model numbers (if any models were trained) for any sites created in the template. The model number is an identifier. If "Edge" appears next to the model number, it indicates that edge detection was enabled during the training operation. You use the scrolling arrows on the right side of the list to scroll through the list when there are more than five measurement sites.

Stage locator

The Stage locator includes site numbers displayed on the wafer shape, which correspond to the site numbers displayed in the Site list. The site numbers always reflect the most recent changes you make to your custom template. Like any Stage locator, you can use the scroll bars and buttons to move the stages in die size units set up in the Wafer control parameters window (described in Section 3), or the Site Teach VP parameters window, described later in this section. The VP Mode and Video buttons perform the same functions described earlier in this section for the Teach Mask Alignment Sites window (Mask teach function).

Param button

Opens the Site Teach VP Parameters window, as shown in Figure 4.22. In this window, you can set up the pattern recognition parameters used for site alignment.

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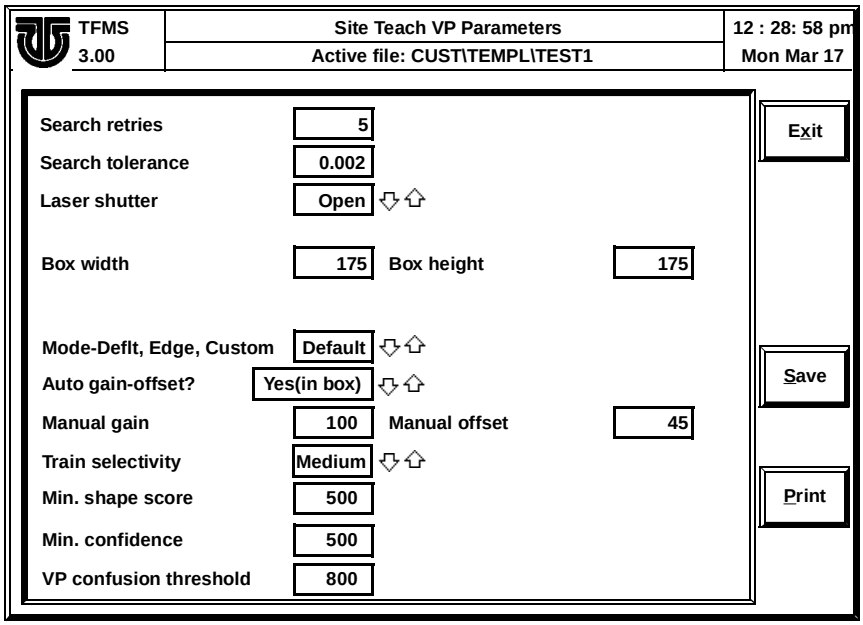
Figure 4.22 Site Teach VP Parameters window



Search retries,
Search tolerance (mm): Specify site alignment parameters used during a wafer measurement. You enable these parameters by teaching the vision processor a generic or specific site model. You enter the maximum number of times you'd like the VP to search for the pattern and the correction tolerance for the site alignment operation.

During site alignment, the VP scans the field of view displayed on the sample viewing monitor for the pattern stored during the *Train* or *Train all* operation. If the VP finds the pattern, the stages move it to the center of the screen and then the system re-checks the pattern. The search is successful if the system can position the pattern within the search tolerance. If the first try is unsuccessful, the system keeps trying until the position is within the correction tolerance or it has tried the maximum number of times (search retries). Once the pattern is within the site correction tolerance, the system applies the offset for the measurement site. If the system cannot correct the position to within the tolerance, or the pattern does not appear in the field of view, a site alignment error message appears.

Laser shutter: Specifies whether the laser shutter is open or closed during the site model train and search operations. Closing the laser shutter improves vision processing for images with faint or sparse features, especially in Edge mode (adds one second to search times). The laser shutter is always closed during the mask

alignment operation, so this field does not appear in the Mask Teach VP Parameters window.

Box width, Box height : Specify the width and height, in pixels, of the pattern stored during Site teach and matched during site alignment. Generally, in high magnification with the sample viewing monitor in VP video mode, a white box with cross hairs appears with this width and height. This is the vision box. Typical box dimensions are 150 pixels, while the vision processor's field of view is 576 x 448 pixels. Always configure a vision box size that is approximately the same size as the feature you're attempting to align on. The VP cannot find a match unless the entire stored pattern (i.e., the entire area outlined by the box) appears in the field of view on the sample viewing monitor. If the vision box is too large, the entire pattern may not be in the field of view during the alignment operations.

You can use different box size parameters for mask alignment and site alignment. You specify the mask alignment box size parameters in the Mask Teach VP Parameters window, described earlier in this section. Mode-Deflt, Edge, Custom, Auto gain-offset? (AGO), Manual gain/Manual offset, *Train selectivity, Min. shape score, Min. confidence, VP confusion threshold*. All of the above parameters operate as they do for the Mask Teach VP parameters described earlier in this section, except they are applied to the images in high magnification.

Function menu

The Function menu displays a list of operations you can perform on the measurement sites displayed in the Site list. If a wafer is not loaded, only *Add*, *Alter*, and *Delete* are selectable. The functions that do not require a VP are also described in Section 3, and are repeated here to provide you with a complete description of the Function menu.

Add / Stage X/Y: You can add a measurement site to your custom template by selecting the X,Y coordinates with the trackball or by entering the X,Y coordinates manually.

To select a site using the trackball a wafer must be loaded.

You can use the trackball to add a measurement site to your custom template by following these steps:

1. Position a measurement site under the laser spot with the trackball.

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The sample viewing monitor displays the area near your measurement site.

2. Select a site in the Site list.

   Your selection turns dark green.

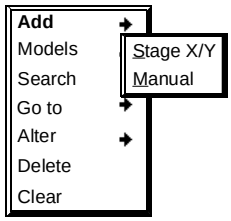
   When the list contains one or more sites, you can select either the last site number (with no coordinates) or one of the existing sites. If there are no sites in the list, select 001.

   If you'd like to select the empty site, and the current list contains five or more sites, scroll to the empty site at the end of the list.

3. Select *Add* in the Function menu.

   The Add menu appears with two options, *Stage X/Y* and *Manual*, as shown in Figure 4.23.

Figure 4.23 Add menu



4. Select *Stage X/Y* in the Add menu.

   The new site appears in the list with the number you selected. You see the current stage coordinates displayed next to the site number. The site you selected, and each site listed after it, are re-numbered. This allows you to insert a site between two existing sites in the list.

   If you selected the empty site, a new empty site number appears after it. Your new site also appears on the Stage locator's wafer shape.

   The system measures the sites in numerical order.

Add / Manual: You can add a measurement site to your custom template by manually entering the X, Y coordinates as follows:

1. Select a site in the Site list.

   Your selection turns dark green.

   When the list contains one or more sites, you can select either the empty site (with no coordinates) or one of the existing sites. If there are no sites in the list, select 001.

   If you'd like to select the empty site, and the current list contains five or more sites, scroll to the empty site at the end of the list.

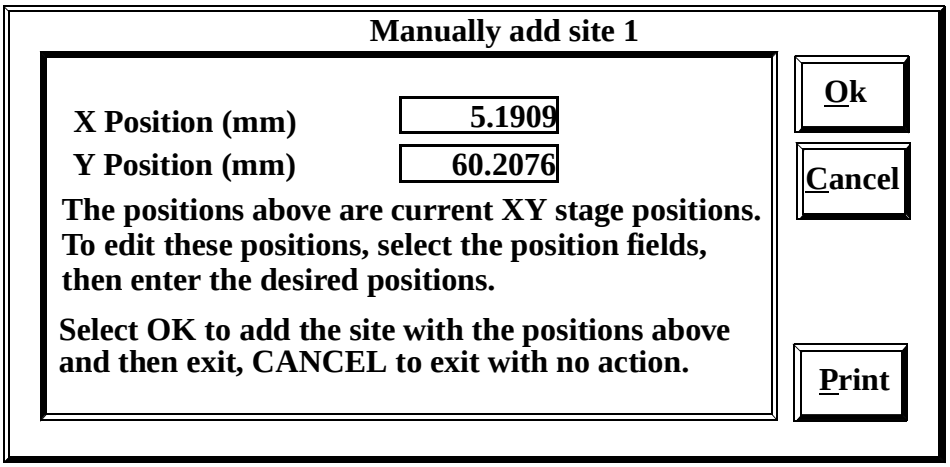
2. Select *Add* in the Function menu.

   The Add menu appears with two options, *Stage X/Y* and *Manual*, as shown in Figure 4.20.

3. Select *Manual* in the Add menu.

   A dialog box appears where you can enter the X,Y coordinates, as shown in Figure 4.24.

Figure 4.24 X, Y coordinates dialog box


Manually add site 1
X Position (mm)
5.1909
Y Position (mm)
60.2076
The positions above are current XY stage positions. To edit these positions, select the position fields, then enter the desired positions.
Select OK to add the site with the positions above and then exit, CANCEL to exit with no action.
Ok
Cancel
Print

4. Enter the X,Y coordinates and select *Ok* in the dialog box.

   The new site appears in the list with the number you selected. You see the current stage coordinates displayed next to the site number. The site you

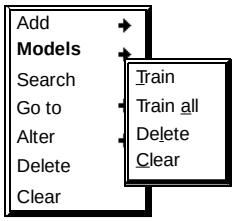
selected, and each site listed after it, are re-numbered. This allows you to insert a site between two existing sites in the list.

If you selected the empty site, a new empty site number appears after it. Your new site also appears on the wafer shape.

Models :When you select *Models* in the Function menu, the Models menu appears with a list of options, as shown in Figure 4.25. You use these functions to teach the VP pattern(s) used to align custom template measurement sites, or to instruct the VP to forget the pattern(s) for one or more sites. During a measurement, when a vision model is associated with a measurement site, the system moves the stages to the vision model coordinates, the VP searches the field of view for the stored model, and the system adjusts the stages to position the laser spot in the intended measurement location.

You must teach mask alignment before teaching any site models. If you don't, a dialog box appears with a reminder message when you select *Models*. If this happens, select *Ok* in the dialog box, perform *Mask teach*, and then open the *Models* menu.

Figure 4.25 Models menu



When site alignment is required, you should begin by defining the measurement coordinates and then define the vision model and its location (if different from the measurement location, i.e., if there is an offset). You perform the first step using the *Add* or *Alter* function. You perform the second step using the *Models*/*Train* or *Train all* function.

Models/Train :Teaches the VP system a pattern (model) associated with a single measurement site, including the offset (if any) between the model and the measurement site. You can perform this operation by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Verify that high magnification is enabled.

   If it is not, select *High* with the Mag button.

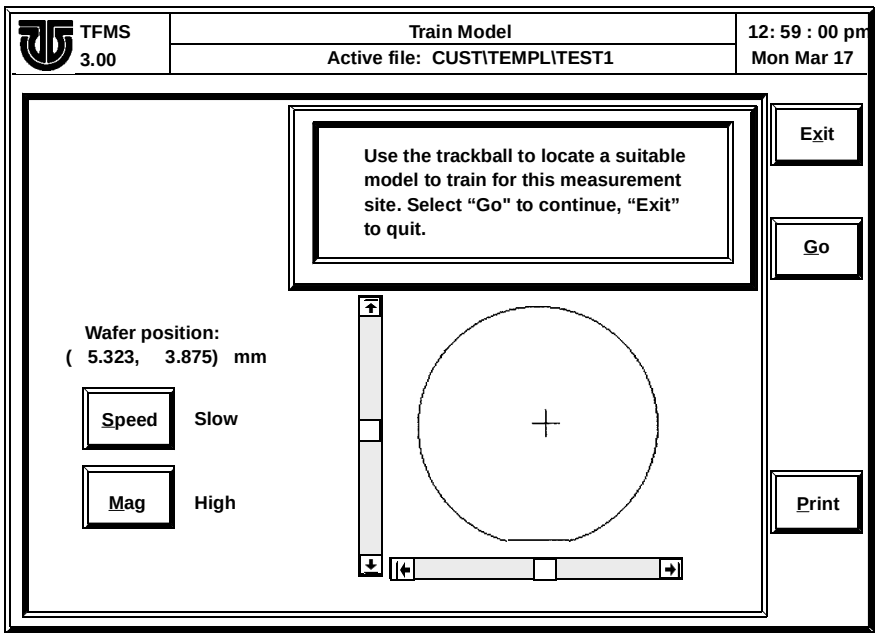
3. Select *Models*/*Train*.

   The Train Model window appears with a message that tells you to locate a suitable model to train for the measurement site, and then select the *Go* button, as shown in Figure 4.26.

   You can select the model in another field of view. Don't select a model that is too far from the measurement site (>500 µm).

   If a model was already trained for the selected site, a dialog box appears asking if you want to delete the current model for the site.

Figure 4.26 Train Model window



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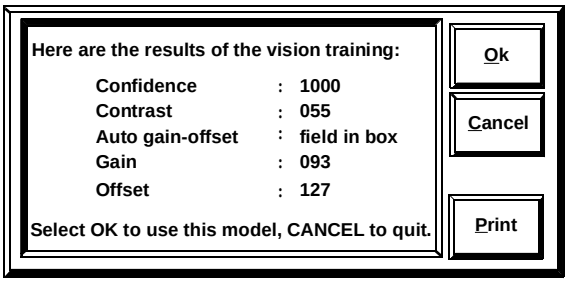
4. Follow the instructions in the Train Model window, and select a suitable model.

   A results dialog box appears displaying the results of the vision training, as shown in the example in Figure 4.27.

Figure 4.27 Vision training results dialog box



5. Select *Ok* in the dialog box if the vision training results are satisfactory.

   The stages move back to the measurement site and the Train Model window reappears with the new wafer position displayed on the wafer shape and a dialog box that says: *This is the measurement location. Use the trackball to adjust the location if desired. Select "Go" to continue, "Exit" to quit.*

   If the results are unsatisfactory, e.g., confidence <600 or the contrast <15, select the *Cancel* button in the dialog box, select a site in the Site list, and repeat the previous steps using a different model for the site.

   If the contrast is too low, select the *Param* button in the Teach Measurement Sites window to open the Site Teach VP Parameters window and select *Yes in box* in the *Auto-gain offset* field. You can also select one of the edge enhancement options in the *Mode -Default, Edge, Custom* field (or use the *VP Mode* button in the Teach Measurement Sites window) before you train a model.

   If the color/contrast of the pattern varies across the wafer, you may have to select *Low* in the *Train selectivity* field and decrease the value in the *Min. shape score* field in the Site Teach VP Parameters window.

6. "Fine tune" the position of the site, and then select the *Go* button in the Train Model window.

Models/Train all: Teaches the VP system a single pattern that is used as a generic model for all measurement sites. This model must be located near each of the measurement sites, at the same relative offset distance. You can perform this operation by following these steps:

1. Use the trackball to display the first measurement site in the vision box and select *Add* in the Function menu.

   The site's X,Y coordinates appear in the site list.

2. Repeat step 1 for the other measurement sites.

3. Select any site in the Site list, and then select *Models*/*Train all*

   A message appears that tells you to position a distinctive pattern in the vision box with the trackball.

4. Select a pattern, and then select the *Go* button.

   Although there is no upper limit for the offset distance between the measurement sites and the models, a maximum distance of three fields of view ensures a better positioning repeatability.

   The VP evaluates the quality of the pattern as a model and displays the evaluation results, as in the Train function.

5. Select *Ok* if the VP results are satisfactory.

   A dialog box appears with a message that asks you if you want to verify the model for all the measurement sites.

   If you select *No* in the dialog box, The VP saves the model and offset, and the same model number (2) appears next to all the sites in the Site list. If edge detection is enabled, the word Edge appears next to the model number in the Site list.

   If you select *Yes* in the dialog box, the stages move successively to the location of each model and site. As the stages move to each location, a dialog box appears that asks you if the site or model appears in the field of view.

   If the results are unsatisfactory, e.g., confidence <600 or the contrast <15, select the *Cancel* button in the dialog box, select a site in the Site list, and

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repeat the previous steps using a different model for the site. For additional recommendations, see step 5 for the Train function on the previous page.

6. Select *Yes* in each dialog box if the site or model appears (even if it is not centered in the field of view), or *No* if it does not appear.

   After you verify the model, a dialog box appears that says: *Learn this pattern for all measurement sites?*

7. Select *Ok* in the dialog box to accept the model.

   The VP stores the information, and the same Model number (2) appears next to all the sites in the Site list. If edge detection is enabled, the word Edge appears next to the model number in the Site list.

   If you selected *No* in any of the verification dialog boxes, another dialog box appears that asks if you want to continue to verify sites and models. If you select *OK* in this dialog box, you must re-teach one or more site coordinates, delete some sites, or train another site model after completing the verification.

The VP system does not use the search function in the verify operation. To use the search function and effectively check that the VP recognizes the models for each site location, you must use the Site visit function, described later in this section.

The VP can only find identical models with the same offset near each of the above trained sites, i.e., if sites are located in the same relative position in different dice.

If you teach the coordinates for a new site after using the Train all function, the new site also receives the model number 2, even though the generic model may not be present at the generic offset distance from the site. To delete the generic model from the new site and train an individual model for that site, perform a Models/Train operation on this site. You'll see a dialog box appear that asks if you want to delete the current model for this site. If you select *Yes* in the dialog box and proceed with the Train operation, the new site receives a new model number (3), while the other sites retain the model number 2.

Models/Delete :Cancels the vision model for a specific measurement site. You can perform this action by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Models* in the Function menu, followed by *Delete* in the Models menu.

   If the site has no Model number, a dialog box appears with a message saying: *There is no model for this site.* Select *Ok* to close the dialog box and return to the Teach Measurement Sites window (skip step 3).

   If the site has a Model number, the stages move to the measurement coordinates for the selected site, and a dialog box appears saying: *Forget model for this site?*

3. Select *Ok* in the dialog box.

   The vision processor performs the unlearning sequence, and the Model number disappears from the selected site in the Site list. The original X,Y coordinates for the measurement location are retained.

Models/Clear :Cancels the vision model(s) for all measurement sites. You can perform this action by following these steps:

1. Select *Models* in the Function menu, followed by *Clear* in the Models menu.

   A confirmation dialog box appears that asks if you want to delete all the vision models.

2. Select *Ok* in the dialog box.

   The vision processor performs its unlearning sequence, and the model numbers disappear from all sites in the Site list. The original X,Y coordinates for the measurement sites are retained.

Search:You can test the vision model and offset, if any, for a site by following these steps:

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1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Search* in the Function menu.

   If the site has a vision model, the stages move to the coordinates for the vision model associated with that site. The system performs site alignment (the VP searches the field view for the stored model, and the system adjusts the stages to position the laser in the intended location). Next, the stages apply the offset to reach the measurement location.

   If your System Manager configured the diagnostics setup to search the neighboring fields of view during the site teach operation, the VP positions your model at each of the four corners of the field of view, searching for another pattern that is similar to your model. If the VP does not find a similar pattern, this verifies that the site model is still unique in the field of view (even if the stages position it close to the edge of the screen). If the VP finds a similar pattern, a message informs you that the model is not unique. If this message appears, you should modify the site teach parameters and repeat the teach operation or teach a new model. For more information on the System Manager setup, see *Main Menu*/*Administration*/*Diagnostics* in Section 7, "System Manager Functions."

   If the site does not have a vision model, the stages move to the measurement location. Except for the sample viewing monitor, which remains in live video mode, this operation is similar to *Go to* (described next).

Go to*/*Site: You can drive the stages to a site by following these steps:

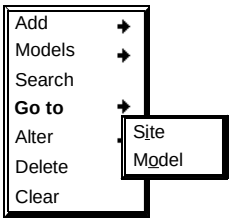
1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The Go to menu appears with two options, *Site* and *Model*, as shown in Figure 4-28.

Figure 4.28 Go to menu



3. Select *Site* in the Go to menu.

   The stages go to the selected site location. The screen blanks briefly while the stages are moving.

   The sample viewing monitor displays the area near your measurement site.

4. Select *Model* in the Go to menu.

   If the site has a vision model, the stages move to the model location; however, the VP system does not perform a search operation.

Alter /Stage X/Y: You can alter a custom template measurement site by selecting the new X,Y coordinates with the trackball or by entering the new X,Y coordinates manually.

To alter a site with the trackball, a wafer must be loaded.

You can use the trackball to alter a custom template measurement site by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Position a measurement site under the laser spot using the trackball.

   The sample viewing monitor displays the area near your measurement site.

   Alternatively, you can use the Go to /Site function to perform this step.

3. Use the trackball to move the stages to the new coordinates.

4. Select *Alter* in the Function menu.

   If the site has a vision model, a message tells you to delete the model before using the Alter function.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*. This menu looks the same as the Add menu shown in Figure 4.20.

5. Select *Stage X/Y* in the Alter menu.

   A confirmation dialog box appears.

6. Select *Ok* in the dialog box to alter the measurement site coordinates.

   The new X/Y coordinates appear next to your selected site in the Site list, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Alter / Manual: You can alter a custom template measurement site by manually entering the X, Y coordinates as follows:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*.

3. Select *Manual* in the Alter menu.

   A dialog box appears where you can enter the new X,Y coordinates.

4. Enter the new X,Y coordinates and select *Ok* in the dialog box.

   The new X/Y coordinates appear next to your selected site in the Site list and next to the wafer shape in the Stage locator, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Delete: You can remove a site from the template by following these steps:

1. Select a site in the Site list.

2. Select *Delete* in the Function menu.

   A confirmation dialog box appears.

3. Select *Ok* in the dialog box to delete the site.

   The site you selected disappears from both the Site list and the wafer shape. Any sites listed after it are re-numbered.

   This function operates identically with or without a site vision model.

Clear: You can remove all sites from a custom template by following these steps:

1. Select *Clear* in the Function menu.

   A confirmation dialog box appears.

2. Select *Ok* in the dialog box to delete all the sites from the template.

   All sites disappear from both the Site list and the wafer shape.

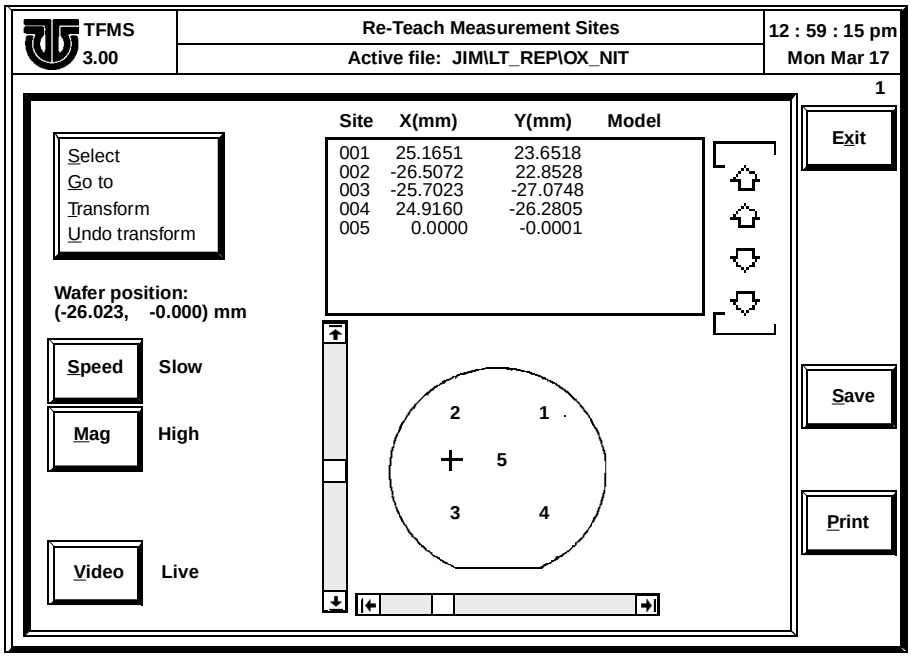
4.5.6 Site re-teach

When you select *Site re-teach* in the Custom template menu, the Re-Teach Measurement Sites window appears, as shown in Figure 4.29. In this window, you can correct the measurement site locations for your entire custom template by re-teaching only three sites. This function is most useful on patterned wafers. To use *Site re-teach*, you must select *Template* as the measurement type and *Custom* as the template type in the Measurement Setup parameters window. In addition, your custom template must contain measurement sites previously set up in the Teach Measurement Sites window, and a wafer must be loaded. If you select *Site re-teach* before these conditions are in place, a dialog box appears with a message reminding you what to do.

To effectively use this function, you must be familiar with the correct measurement site locations.

The Re-teach Measurement Sites window displays a Stage locator at the bottom, a Site list at the upper right side, and a Function menu in the upper left corner.

Figure 4.29 Re-teach Measurement Sites window



Typically, you need to re-teach your template sites after you re-teach mask alignment and find that all your measurement sites are a little off in the same direction. The template sites must be shifted by an X,Y translation and/or a wafer rotation to correct their locations. You perform the re-teach operation to return the measurement sites to the locations on the wafer where they were originally taught.

If you set up your template with an offset between the vision model and the measurement site location, this offset is automatically maintained as the measurement sites are re-taught. Do not attempt to modify the vision model or the offset using this function; use *Site teach* instead.

If your custom template contains only one or two sites, or if only some of the sites require modification, use the *Alter* function in the Teach Measurement Sites window (*Site teach* operation).

Stage locator

The Stage locator includes site numbers displayed on the wafer shape, which correspond to the site numbers displayed in the Site list. Like any Stage locator, you can use the scroll bars and buttons to move the stages in die size units. The *Video* button performs the function described earlier in the Teach Mask Alignment

Sites window (*Mask teach* function). A *VP Mode* button does not appear, since vision models are not taught or modified in this window.

Site list

The Site list displays the measurement site numbers with their X,Y coordinates and any model numbers. The model numbers and Edge designation (if any) are retained during the reteach operation.

Function menu

The Function menu displays a list of functions you can perform within the re-teach operation.

Select: Used with the *Go to* function to select one of the three sites to re-teach.

You can select a site by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The stages go to the listed site coordinates.
   The sample viewing monitor displays the area near the site.

3. Use the trackball to move to the correct measurement site location.

   You can toggle between high and low magnification by selecting the *Mag* button. For optimum placement, make your final adjustment in high magnification.

4. Select *Select* in the Function menu.

   The site number in the wafer shape changes from black to red, which identifies the selected site. The system remembers the old coordinates and records the current X, Y stage coordinates, which become the new coordinates for this site after you perform a transformation. (See *Transform* on the following page)

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To perform a re-teach operation, you must select three sites, preferably as distant as possible from each other.

If you attempt to select another site after selecting three sites, a message reminds you that only three sites are required.

You can undo a site designation by following these steps:

1. Select a previously selected site in the Site list, which has a corresponding red site number in the wafer shape.

   Your selection turns dark green in the Site list.

2. Select *Select* in the Function menu.

   A dialog box appears informing you that the re-teach selection is canceled.

3. Select *Ok* in the dialog box.

   The site number in the wafer shape changes from red to black indicating that the site returned to its original condition.

Go to: You can drive the stages to a specific measurement site location by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The stages go to the listed site coordinates.

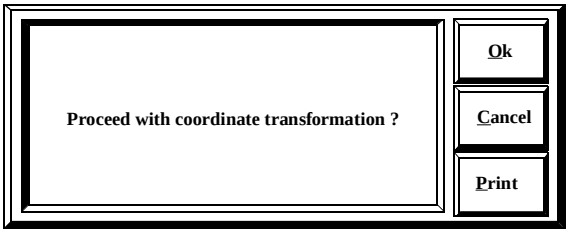
   The sample viewing monitor displays the area near the site.

Transform: You use this function after selecting three sites. You can transform your template by following these steps:

1. Select *Transform* in the Function menu.

   If you selected 3 sites, a dialog box appears, as shown in Figure 4.30.

Figure 4.30 Transform dialog box



If you selected fewer than 3 sites, a dialog box appears reminding you that 3 sites must be selected.

2. Select *Ok* in the dialog box.

   The system calculates the X,Y and theta offset between the old and new coordinates for the 3 selected sites and applies this offset to all the sites in the template. The Site list displays the new X,Y coordinates.

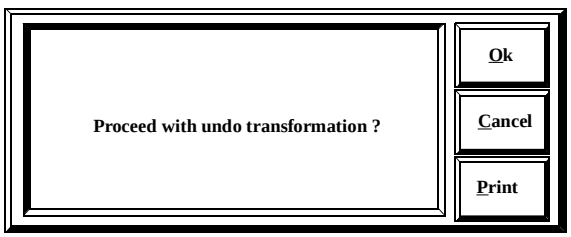
   If you taught sites with models, the VP system retains the offsets between the models and the sites, leaving the models unchanged.

Undo transform: You use this function to undo the most recent transformation performed in the active job file and restore the template to its previous state. You can perform an *Undo transform* operation any time after a *Transform* operation (i.e., after you exit the window or close the job file). If you're not satisfied with the new (transformed) site locations, you can undo the most recent transformation by following these steps:

1. Select *Undo transform* in the Function menu.

   A dialog box appears, as shown in Figure 4.31.

Figure 4.31 Undo transform dialog box



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If you didn't perform a transformation, or if you try to undo the transformation a second time, a dialog box appears informing you that the undo operation is not possible.

2. Select *Ok* in the dialog box.

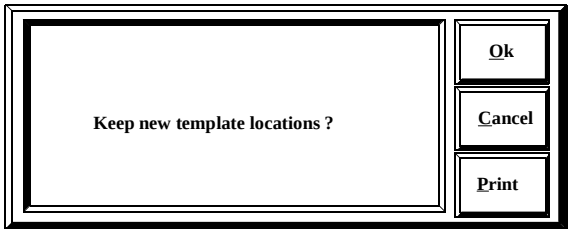
   The system subtracts the X,Y and theta offset applied during the previous *Transform* operation and restores the original site locations. The Site list displays the original X,Y coordinates.

   At this point, you have the option to de-select one or more of the 3 selected sites, select new sites, and perform another transformation.

Exit button

Closes the window. When you select the *Exit* button after performing a Transform operation without selecting the *Save* button, a dialog box appears, as shown in Figure 4.32.

Figure 4.32 New template dialog box



Select *Ok* to retain the new site locations. If you select *Cancel*, it is the same as performing an *Undo transform* operation. In either case, you return to the Template menu.

When you select the *Exit* button after performing an *Undo transform* operation without selecting the *Save* button, the dialog box in Figure 4.29 appears. In this case, select *Ok* to retain the *Undo transform* operation or *Cancel* to cancel it (and restore the original transformation).

Because the Site re-teach function applies the same offset to all of the template sites, make sure you select 3 sites that have a consistent offset relative to the desired location. This may be difficult if the original sites were taught loosely, which is sometimes done when site-by-site correction is used.

In addition, because the Site re-teach function is designed fortemplates that cover a fairly large area, if your template is smaller than about a die, unsatisfactory results can occur.

After performing a transform, use the Site visit function to see if the transformed coordinates are satisfactory. If they are not, undo the transform and manually re-teach your site locations in the Teach Measurement Sites window (*Site teach* function).

Because the Transform operation calculates some average offset based on three of the sites, the result is not as accurate as the teaching of each site individually (with Alter or Alter and Train). Therefore, if the template consists of only 4 or 5 sites, the accuracy of a new teaching outweighs the small amount of time you save by using the Transform operation.

4.5.7 Site visit

When you select *Site visit* in the Custom template menu for sites that have vision models trained, a dialog box asks if you want the VP to search for the models before positioning the sites. If the VP does not find or recognize a model, a message informs you.

When you select *Yes* or *No* in the above dialog box, or no models are trained, a dialog box appears that says: *Visit sites in both High and Low magnifications?* You select *Yes* to visit sites in both high and low magnifications or *No* to visit sites in high magnification only. After making your selection, the stages move to each site in numerical order, as displayed on the sample viewing monitor in the specified magnification(s). During this operation, the Site visit window appears on the TFMS monitor, depicting each measurement site as a numbered box on a wafer shape. Each numbered box turns light purple momentarily as the stages pause, then dark purple as the stages move to the next site. A *Halt* button appears in the window's right margin.

Halt button

Halts the Site visit operation. When you select the *Halt* button, after the system visits the current site, a dialog box appears that says*: Continue visiting sites*? Select *Cancel* to cancel the *Site visit* operation or *Ok* to continue.

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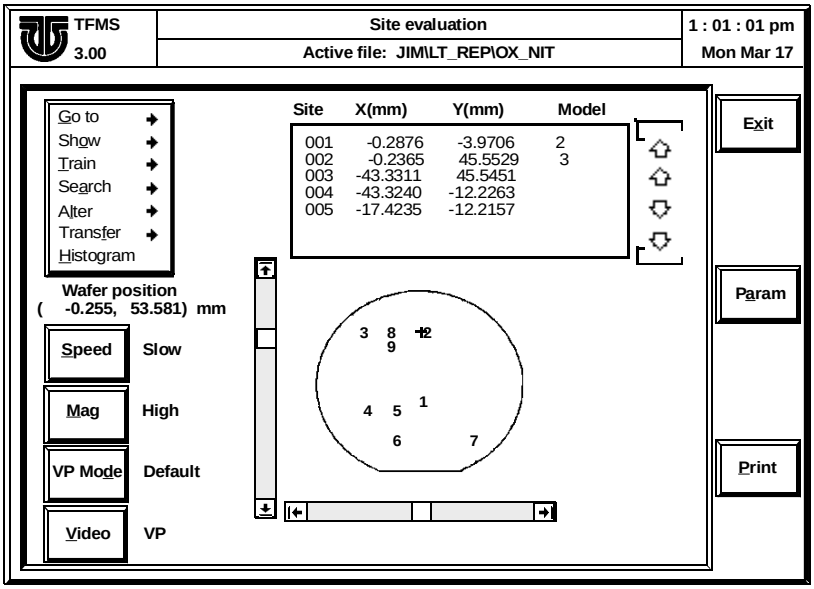
4.5.8 Site evaluate

When you select *Site evaluate* in the Custom template menu, the Site evaluation window appears, as shown in the example in Figure 4.33. In this window, you can evaluate wafer features as site alignment models and compare wafer images to a stored test model image. You can use this information to diagnose site alignment problems or verify that the stored model is satisfactory. The operations in this window function in high magnification. You can perform similar operations in low magnification in the Mask evaluation window, described earlier in this section. You must load a wafer before using this function. If a wafer is not loaded, a reminder message appears.

If *Perform mask alignment* is not enabled in *Setup*/*Recipe* /*Wafer*, you must select *Mask align* in the Custom template menu before opening this window.

If you open this window and Mask alignment was not taught, a dialog box appears reminding you to do so. If you see this dialog box, select *Ok* and then teach Mask alignment before reopening the window.

Figure 4.33 Site evaluation window



In this window, you see a Site list at the upper right side, a Stage locator at the bottom and a Function menu in the upper left corner.

Site list

If you open this window before teaching any measurement sites for your custom template, the Site list only displays an empty site 001, and the wafer shape is blank (except for the cross hair). If you open this window after teaching some measurement sites, it looks similar to the example in Figure 4.33. The Site list displays the measurement sites stored during Site teach, and the site numbers also appear in the wafer shape. In the Site list, each site entry includes X,Y coordinates. Some, all, or no entries include a model number, which is an identifier indicating that the site was taught with site-by-site pattern recognition. If "Edge" appears next to the model number, it indicates that edge detection was enabled during the *Site teach* operation.

Stage locator

If the wafer pitch is entered in *Setup*/*Recipe*/*Wafer*, you can use the Stage locator's scroll bars and buttons to move the stages in die size units. You can use the *Video* and *VP mode* buttons to perform the functions described in the Teach Mask Alignment Sites window, described earlier in this section under Mask teach. You can use the *Param* button to open the Site teach VP Parameters window and customize the site train and search setup. When you open this window, the system automatically switches to high magnification. Generally, you should remain in high magnification and *VP* video mode while you're working in this window.

Function menu

The Function menu displays a list of operations you can perform using measurement sites ("site" operations) or any test areas on the wafer ("test" operations, performed on site candidates).

Go to Site: You can drive the stages to a specific measurement site by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The Go to menu appears with two options, as shown in Figure 4.34.

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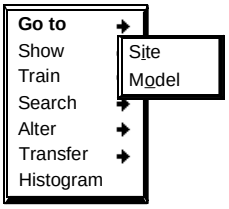
Figure 4.34 Go to menu



3. Select *Site* in the Go to menu.

   The stages go to the selected site coordinates. The screen blanks briefly while the stages move.
   The sample viewing monitor displays the area near the selected site.

Go to / Model : You can drive the stages to a specific measurement site model by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Go to* in the Function menu.

   The Go to menu appears with two options, as shown in Figure 4.30.

3. Select *Model* in the Go to menu.

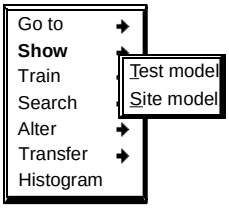
   The stages go to the selected model coordinates. The screen blanks briefly while the stages move.
   The sample viewing monitor displays the area near the selected site model.

Show / Test model: After training a test model, you can view the stored test model image by following these steps:

1. Select *Show* in the Function menu.

   The Show menu appears with two options, as shown in Figure 4.35.

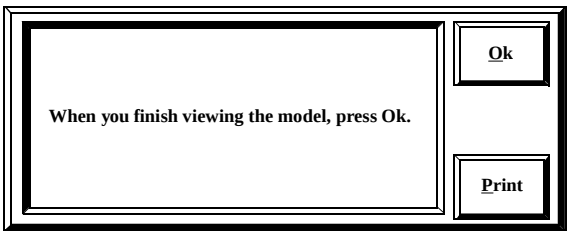
Figure 4.35 Show menu



2. Select *Test model* in the Show menu.

   The VP displays the test model stored during a Train test model operation performed since opening the Site evaluation window. The sample viewing monitor displays the test model, which only includes the image that was within the vision box at train time. The TFMS monitor displays a dialog box, as shown in Figure 4.36. If the VP does not have a stored test model, you see a dialog box reminding you to train a test model first.

Figure 4.36 Show test model dialog box



3. Select *Ok* in the dialog box.

   You return to the Site evaluation window, and the sample viewing monitor returns to the previous field of view.

Show ISite model: You can view a measurement site's stored model image by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Show* in the Function menu.

The Show menu appears with two options, as shown in Figure 4.29.

3. Select *Site model* in the Show menu.

   The VP displays the site model associated with the selected site. The sample viewing monitor displays the site model, which includes only the image that was within the vision box at train time. The TFMS monitor displays a dialog box, as shown in Figure 4.36.

   If you selected an empty site at the end of the Site list or a site without a site model, a dialog box appears with a reminder message.

4. Select *Ok* in the dialog box.

   You return to the Site evaluation window, and the sample viewing monitor returns to the previous field of view.

Train / Test model: You can train a test model by following these steps:

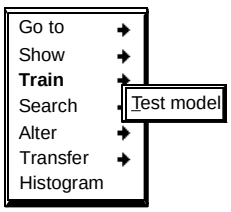
1. Use the stage locator and/or the trackball to move the stages to a field of view containing a feature you'd like to evaluate.

   If you're in VP video mode, you see a white box with cross hairs on the sample viewing monitor. This is the vision box, which outlines the region to be learned by the VP. You can change its size in the Site teach VP parameters window, described earlier in this section. You move the desired pattern into the vision box using the trackball.

1. Select *Train* in the Function menu.

   The Train menu appears with one option, as shown in Figure 4.37.

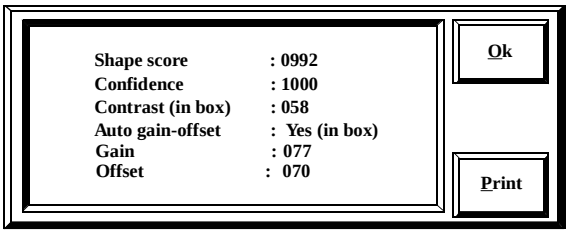
Figure 4.37 Train menu



2. Select *Test model* in the Train menu.

   The VP system converts the image within the vision box to a model representation and stores it. This is the training step. Then the VP system immediately searches the field of view for the image it just trained. If the search is successful, you see a dialog box that displays several values, as shown in Figure 4.38. These quantities are explained next under *Search Test model.*

Figure 4.38 Train test model results dialog box



   If the search is unsuccessful, an error message appears. The most common reasons for failure are: the feature is not unique within the field of view or the contrast is poor. An unsuccessful search indicates that the feature is not a good choice.

3. Select *Ok* in the dialog box.

   You return to the Site evaluation window.

Search / Test model: You can search the field of view for a stored test model by following these steps:

1. Use the stage locator to move to the desired field of view to search for your test model.

2. Select *Search* in the Function menu.

   The Search menu appears with two options, as shown in Figure 4.39.

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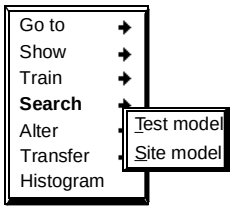
Figure 4.39 Search menu

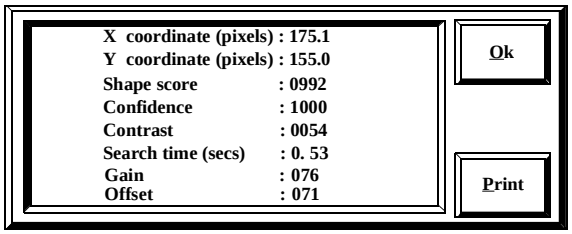


3. Select *Test model* in the Search menu.

The VP searches the field of view for the test model stored during a Train Test model operation that was performed since opening the Site evaluation window. If the VP does not have a stored test model, you see a dialog box that reminds you to train a test model first. If the search is successful, a dialog box appears that displays several values, as shown in Figure 4.40. On the sample viewing monitor, the vision box outlines the feature that the VP found. In the lower left corner of the box you see a 1 (this is an identifier), and in the lower right corner of the screen you see shape score and confidence results.

Whenever the VP searches for a model, the entire image must be within the field of view in order for the VP to find it.

Figure 4.40 Search test model results dialog box



If the search is unsuccessful, an error message appears. The most common reasons for failure are: a model is not entirely or not at all present in the field of view, the model is not unique within the field of view, or the feature characteristics are not sufficiently similar to the model. If the feature is not unique, the sample viewing monitor displays two vision boxes that outline the

two features with the best shape scores (best match to the stored model). The box with the highest shape score is identified by the number 1.

4. Select *Ok* in the dialog box.

   You return to the Site evaluation window.

   The values in the results dialog box are defined as follows:

   X coordinate (pixels), Y coordinate (pixels): Designate the X and Y coordinates of the upper left corner of the vision box outlining the matched feature. X=0, Y=0 designates the upper left corner of the screen, which is 576 pixels wide (X) and 448 pixels high (Y).

   Shape score: Indicates the quality of resemblance between the pattern found and the model.

   Confidence: Indicates how unique the pattern is in the field of view.

   Contrast: Indicates how much gray scale variation is contained in the field of view.

   Search time (secs): Displays the amount of time it took the VP system to search the field of view and identify the feature.

Search / Site model: You can search the field of view for a stored site alignment site model by following these steps:

1. Select one of the measurement sites in the Site list.

   Your selection turns dark green.

2. Use the stage locator to move to the desired field of view to search for your test model.

3. Select *Search* in the Function menu.

   The Search menu appears with two options, as shown in Figure 4.39.

4. Select *Site model* in the Search menu.

The VP searches the field of view for the site model stored during a previous Site teach operation (unlike the Site teach search, where the stages move to the model location before searching the field of view).

If the search is successful, a dialog box appears that displays several values, as shown in Figure 4.40. On the sample viewing monitor, the vision box outlines the feature that the VP found. In the lower left corner of the box you see a 1 (this is an identifier), and in the lower right corner of the screen you see shape score and confidence results.

The values in the results dialog box are defined earlier in this section, under *Search Test model*.

Whenever the VP searches for an image model, the entire image must be within the field of view in order for the VP to find it.

If the search is unsuccessful, an error message appears. The most common reason for failure is a feature that is not unique within the field of view. This results in a low confidence score and indicates that the feature is not a good choice. If the feature is not unique, the sample viewing monitor displays two vision boxes that outline the two features with the highest shape scores (best match to the stored model).

5. Select *Ok* in the results dialog box.

   You return to the Site evaluation window.

Alter Stage X/Y: You can alter the site coordinates by selecting the new X,Y coordinates with the trackball or by entering the new X,Y coordinates manually. To alter a site with the trackball, a wafer must be loaded.

You can use the trackball to alter a measurement site by following these steps:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Position a measurement site under the laser spot using the trackball.

   The sample viewing monitor displays the area near your measurement site.

3. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*.

4. Select *Stage X/Y* in the Alter menu.

   The new X/Y coordinates appear next to your selected site in the Site list, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Alter / Manual: You should only use the manual option if you know the exact coordinates of the new measurement site. You can alter a measurement site by manually entering the X, Y coordinates as follows:

1. Select a site in the Site list.

   Your selection turns dark green.

2. Select *Alter* in the Function menu.

   The Alter menu appears with two options, *Stage X/Y* and *Manual*.

3. Select *Manual* in the Alter menu.

   A dialog box appears where you can enter the new X,Y coordinates.

4. Enter the new X,Y coordinates and select *Ok* in the dialog box.

   The new X/Y coordinates appear next to your selected site in the Site list and next to the wafer shape in the Stage locator, replacing the original X/Y coordinates. The site number is also re-positioned on the wafer shape.

Transfer/Model to flpy: This function allows you to copy a model to a floppy disk (to send to Therma-Wave for diagnostic purposes).

You can copy a model to a floppy disk by following these steps:

1. Select a site with a model in the Site list.

2. Select *Transfer* in the Function menu.

   The Transfer menu appears with three options, as shown in Figure 4.41.

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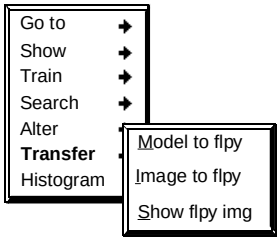
Figure 4.41 Transfer menu



3. Select *Model to floppy* in the Transfer menu.

   A dialog box appears that asks you to insert a DOS formatted disk into the floppy disk drive.

4. Follow the directions in the dialog box.

   The system copies the selected site model (image in vision box) to your floppy disk.

Transfer/Image to flpy: You can copy a model's field of view image to a floppy disk by following these steps:

1. Select a site with a model in the Site list.

2. Select *Transfer /Image to flpy* in the Transfer menu.

3. Move the trackball to the desired field of view, and insert a DOS formatted disk into the floppy drive.

   The system copies the selected field of view image to your floppy disk.

Transfer/Show flpy image : You can display a model's field of view image that is stored on a floppy disk by following these steps:

1. Select any model in the Site list.

2. Select *Show flpy img* in the Transfer menu and insert the disk with the desired image into the floppy drive

   The system displays the floppy disk image on the sample viewing monitor.

Histogram : You can use the histogram function to display the distribution of gray scale values for the current (high magnification) field of view on the sample viewing monitor. This function is useful for optimizing the gain and offset used by the VP system for the active job file. You can manually adjust the gain to change the image contrast and manually adjust the offset to change the overall darkness or brightness of the image. These settings and the automatic gain and offset setting are described in the "Optimizing the vision gain and offset" tutorial in your "Getting Started" manual. You can view a histogram for an area (field of view or vision box) on a wafer by following these steps:

1. Use the stage locator to move to the desired field of view where you'd like to display a histogram.

2. Select the *Param* button

   The Site Teach VP Parameters window appears.

3. Select *Yes, Yes (in box),* or *No* in the *Autogain-offset* (AGO) field.

   Yes = optimized gain and offset (AGO) in the field of view

   Yes in box = AGO in the vision box

   No = Use the manual gain and offset values in Site Teach VP parameters window

4. Select *Histogram* in the Function menu.

   After the VP creates the histogram, it appears on the sample viewing monitor with AGO enabled in the vision box, as shown in the example in Figure 4.42.

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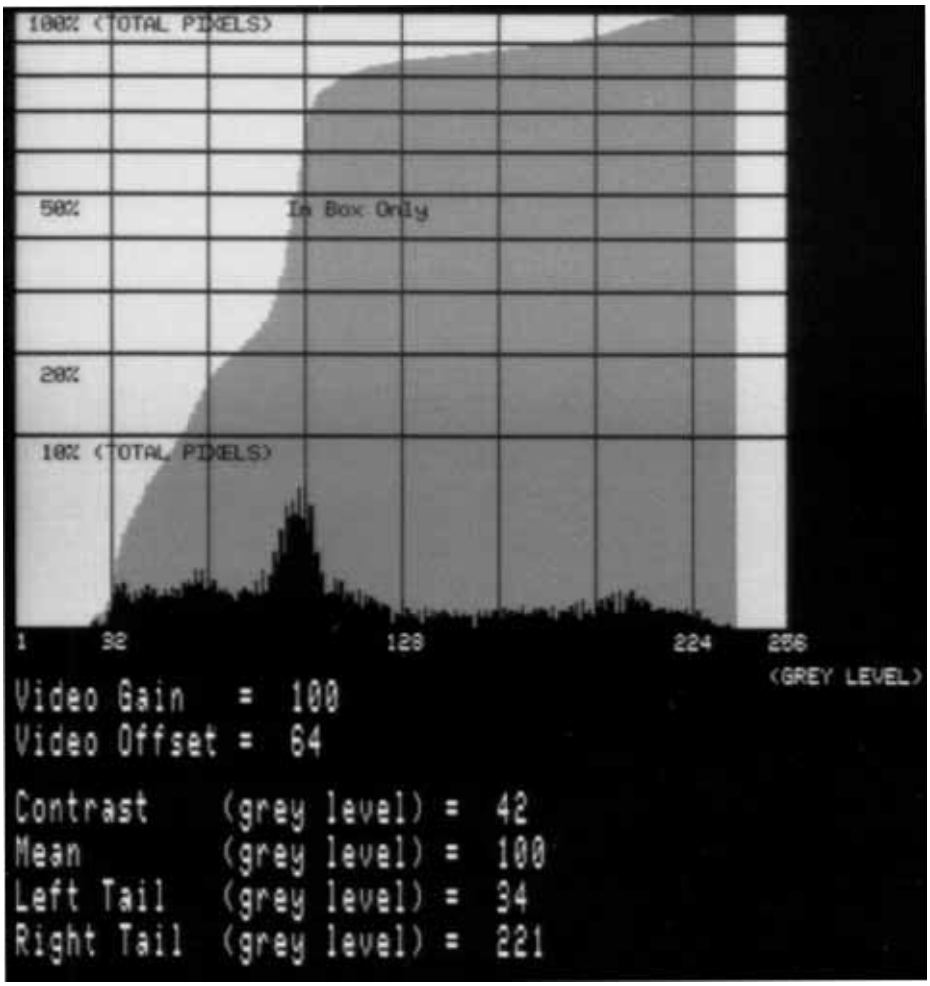
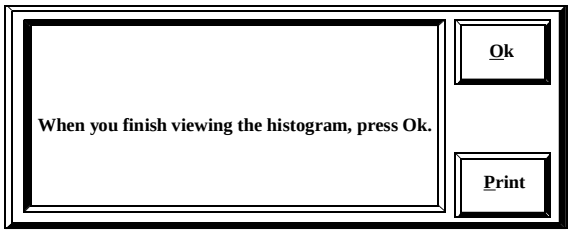
Figure 4.42 Histogram (AGO in vision box)



A dialog box appears on the TFMS monitor, as shown in Figure 4.43.

Figure 4.43 Show histogram dialog box



5. Select *Ok* in the dialog box.

You return to the Site evaluation window, and the sample viewing monitor returns to the previous field of view.

Following is a description of the histogram display:

In the center of the display you see two histograms plotted on the same axes. Each bin on the horizontal axis represents a specific gray level intensity, where 1 = dark and 256 = bright. The vertical axis is a pseudo-logarithmic representation of the fraction of total pixels. The black histogram displays the fraction of total pixels that have the given light intensity. The gray histogram is a cumulative display (i.e., displays the fraction of total pixels that have the given intensity or less).

Below the histograms you see a caption listing the following quantities of interest:

:

Video gain, Video offset:If *No* is selected for AGO in the Site Teach VP Parameters window, the histogram displays the manual gain and offset values. If *Yes* (*in box*) is selected for AGO, the VP system automatically adjusts the gain and offset so all gray levels in the vision box range from 32 to 224 and the histogram displays these values, as shown in Figure 4.39. If *Yes* is selected for AGO, the VP system automatically adjusts the gain and offset so all gray levels in the field of view range from 32 to 224 and the histogram displays these values. If edge enhancement is enabled, the histogram displays the distribution of gray levels before applying the edge transformation. For more information on these parameters, see the Site teach VP parameters window, later in this section.

Contrast:Indicates how much gray scale variation is contained in the field of view. Specifically, the contrast is the standard deviation of the gray scale values. A contrast of 30 is good, while the maximum realistic value is about 100.

Mean :Displays the mean gray level for the field of view.

Left Tail, Right Tail:Indicate the gray level for 1% and 99%, respectively, of the total number of pixels (i.e., 1% and 99% points on the cumulative histogram).

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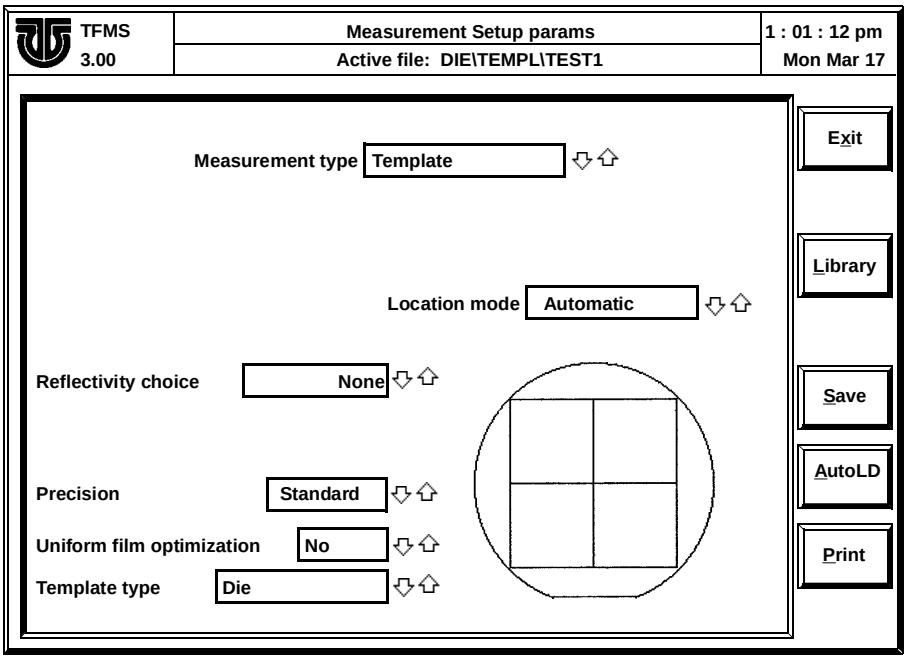
4.6 DIE TEMPLATE MENU

Before you can select *Setup*/*Recipe*/*Die template*, you must open a job file, load a wafer, and select *Template* as the Measurement type and *Die* as the Template type in the Measurement Setup parameters window. When you select *Die* as the template type, the die template measurement parameters appear with a default wafer map, as shown in Figure 4.44. Before you teach the die pitch, only four dice appear on the wafer map. The corresponding die pitch is 70 mm for a 200 mm wafer, 53 mm for a 150 mm wafer, 44 mm for a 125 mm wafer, and 35 mm for a 100 mm wafer.

Figure 4.44 Measurement Setup parameters window (die template measurement)

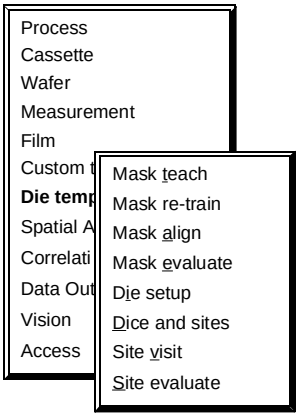


After you select the *Exit* button in the Measurement Setup parameters window, the Recipe menu reappears and the *Die template* option is now selectable.

After configuring your job file's measurement setup for a die template, you can select *Setup*/*Recipe*/*Die template*. When you select this option, the Die template menu appears, as shown in Figure 4.45. The mask related options and *Site visit* and *Site evaluate* operate identically to their corresponding custom template menu options, described earlier in this section. In addition, The Die template menu also

includes *Die setup* and *Dice and sites* options, which are described on the following pages.

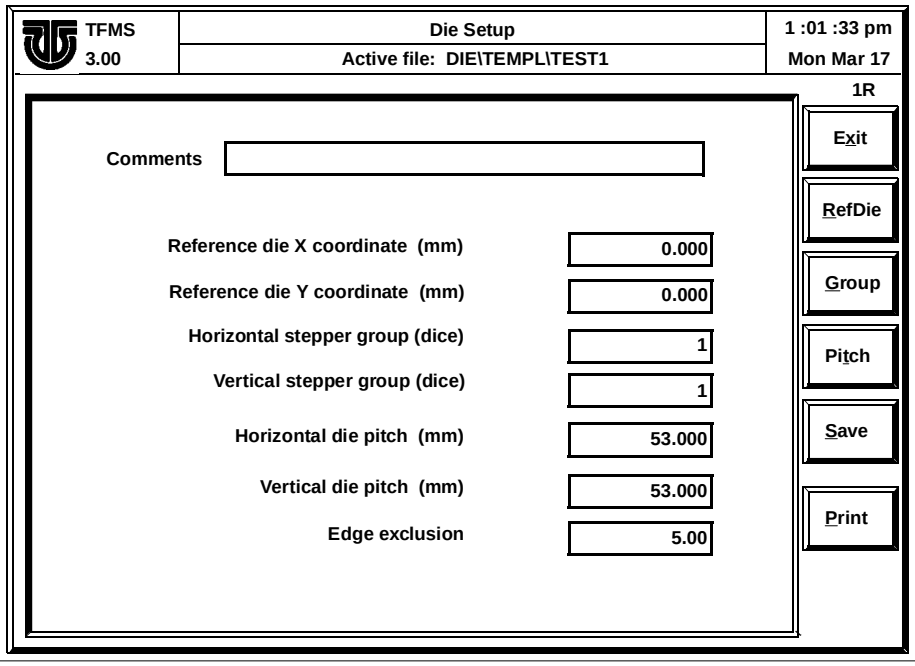
Figure 4.45 Die template menu



4.6.1 Die setup

When you select this option in the Die template menu, the Die Setup window appears, as shown in Figure 4.46. You see three new buttons, *RefDie*, *Group*, and *Pitch* in the window's right margin. In this window, you define your die setup's wafer grid, which is required for dice and sites selection.

Figure 4.46 Die Setup window



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Comments

Specify any information you like, e.g., the process step, sites, or dice to save in your job file.

Reference die X coordinate (mm), Reference die Y coordinate (mm)

Specify a die on a wafer that serves as a reference point for identifying the relative positions of the other dice. Typically, the reference die's x and y coordinates are located at its lower left corner (origin of the reference die).

Horizontal stepper group (dice), Vertical stepper group (dice)

Specify the smallest unit (in dice) that repeats identically on a wafer when all the dice on that wafer are not identical.

Horizontal die pitch (mm), Vertical die pitch (mm)

Specify the dimensions of a single die defined as the distance from one die corner to the next die corner in the horizontal and vertical directions (even if all the dice on a wafer are not identical – but they must have the same dimensions).

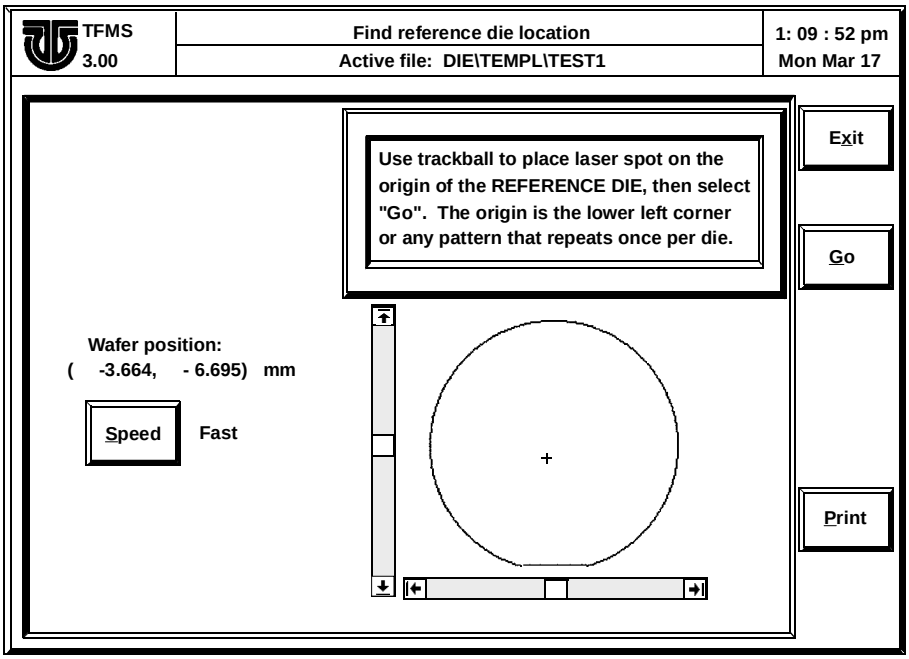
Edge exclusion

Specifies the distance from the edge of a wafer that is not included in the measurement area. Any die that is located entirely or partially in this area is excluded from all measurements.

RefDie button

When you select the *RefDie* button, the Find reference die location window appears, as shown in Figure 4.47. In this window, you can select the reference die.

Figure 4.47 Find reference die location window


TFMS
3.00
Find reference die location
Active file: DIE\TEMPL\TEST1
1: 09 : 52 pm
Mon Mar 17
Use trackball to place laser spot on the origin of the REFERENCE DIE, then select "Go". The origin is the lower left corner or any pattern that repeats once per die.
Exit
Go
Wafer position:
(-3.664, - 6.695) mm
Speed
Fast
Print

You follow the screen instructions and use the trackball to place the laser spot on the lower left corner of the reference die in low magnification, and select the *Go* button.

You fine align in high magnification, following the instructions in the Find reference die location window. The coordinates of the lower left corner of the reference die appear in their respective fields in the Die Setup window.

Group button

If all the dice are not identical, you can select the group button to define a group of dice. When you select the *Group* button in the Die Setup window, the stages move

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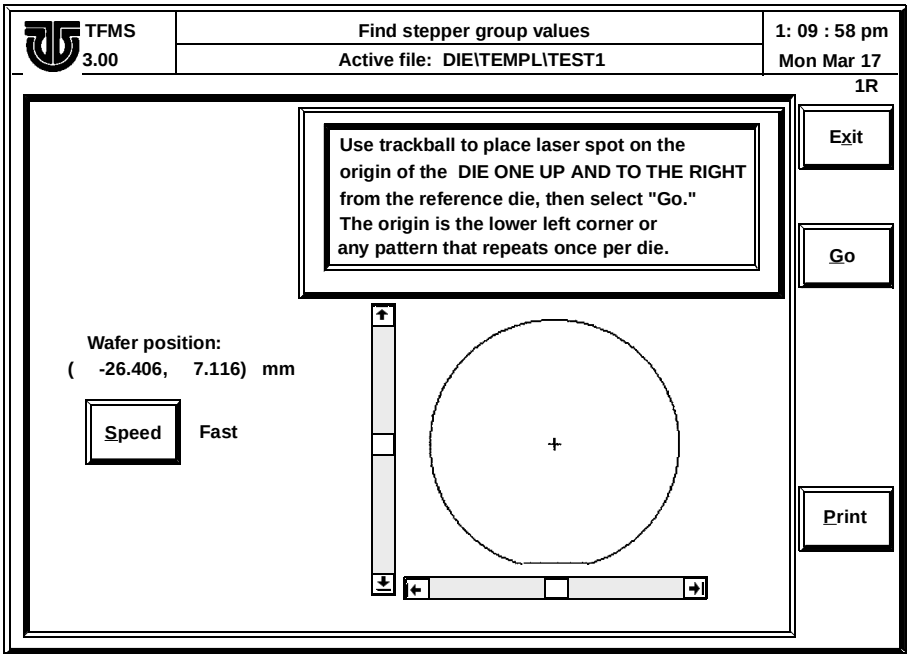
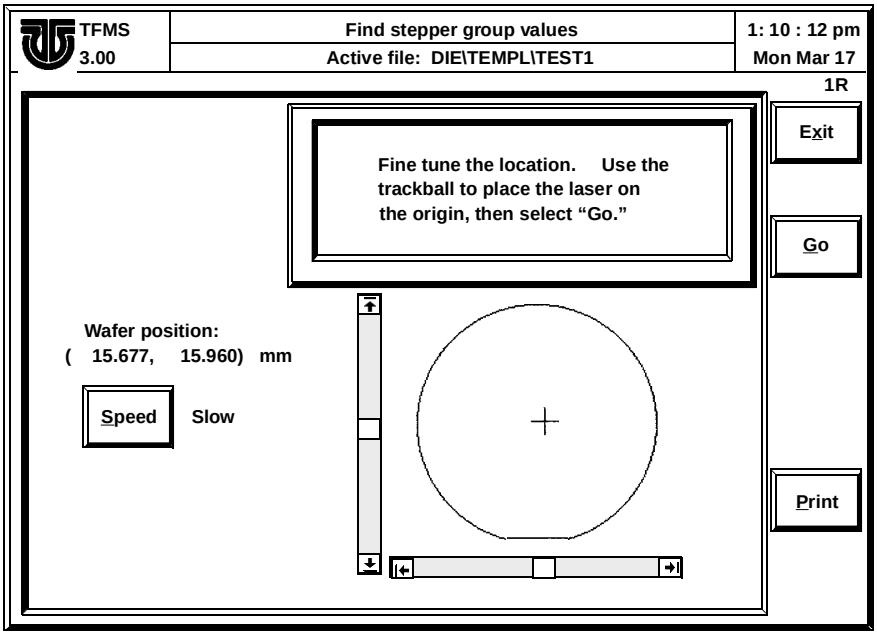
to the origin of the reference die and the Find stepper group values window appears, as shown in Figure 4.48.

Figure 4.48 Find stepper group values window


TFMS
3.00
Find stepper group values
Active file: DIE\TEMPL\TEST1
1: 09 : 58 pm
Mon Mar 17
1R
Exit
Use trackball to place laser spot on the origin of the DIE ONE UP AND TO THE RIGHT from the reference die, then select "Go." The origin is the lower left corner or any pattern that repeats once per die.
Go
Wafer position:
(-26.406, 7.116) mm
Speed
Fast
Print

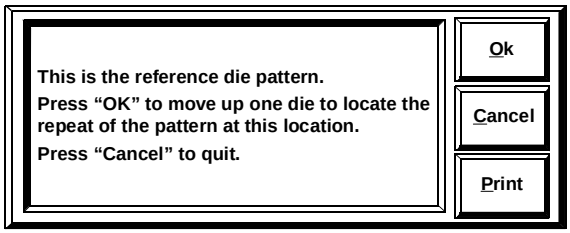
You follow the directions in the dialog box and place the laser spot on the origin (lower left corner) of the next die up and to the right from the reference die, then select the *Go* button. The new wafer position coordinates appear above the *Speed* button, and the crosshair moves to these coordinates on the wafer shape. The system switches to high magnification and the screen instructions tell you to fine tune the location, as shown in Figure 4.49.

Figure 4.49 Find stepper group values window (after selecting the *Go* button)



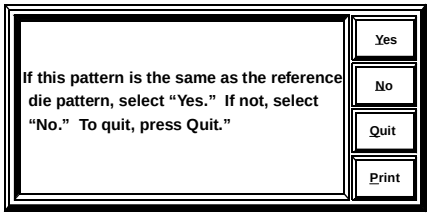
You fine tune the location by placing the laser spot on the origin of the die using the trackball, and then selecting the *Go* button. This operation performs a die pitch measurement near the reference die. The Die Setup window reappears with a dialog box, shown in Figure 4.50.

Figure 4.50 Reference die pattern dialog box


This is the reference die pattern.
Press "OK" to move up one die to locate the repeat of the pattern at this location.
Press "Cancel" to quit.
Ok
Cancel
Print

You follow the instructions in the dialog box, memorize the reference die pattern, and select the *Ok* button. The stage moves up one die. Compare the pattern at this location with the pattern at the origin of the reference die. Another dialog box appears, as shown in Figure 4.51.

Figure 4.51 Verify pattern dialog box



You select *No* in the Verify pattern dialog box if the pattern is not the same as the reference die. The stage moves up one more die. The system repeats this operation until you find a pattern that is identical to the origin of the reference die. You select *Yes* in the Verify pattern dialog box if the pattern is the same as the reference die. This determines the vertical stepper dimensions for the group (in number of dice).

The stages return the wafer to the reference die position. Another Reference die pattern dialog box appears asking you to select the *Ok* button to move one die to the right to locate the horizontal repeat of the pattern. Select *Ok* in the Reference die pattern dialog box. The Verify pattern dialog box in Figure 4.51 reappears. You select *No* in the Verify pattern dialog box to move right one more die if the pattern is not the same as the reference die in the horizontal direction. You select *Yes* in the Verify pattern dialog box if the pattern is the same as the reference die. The Die Setup window reappears displaying the horizontal stepper group dimensions and the vertical stepper group dimensions in their respective fields. If the pattern is the same for all the dice, the stepper group dimensions are one die horizontal and one die vertical (same as the default).

Pitch button

When you select this button, the Find die pitch values window appears, which looks similar to the Find stepper group values window, shown in Figure 4.49. In this window, you can teach the die pitch. You can do this by following the screen instructions that tell you to use the trackball to place the laser spot on the origin of the die that is one up and to the right from the reference die and then select the *Go* button.

The system uses the lower left corners of three dice, first in low magnification and then in high magnification, to determine the horizontal die pitch and the vertical die pitch. Following are the dice: the die directly above and to the right of the reference die, the die at the lower left near the wafer edge, and the die at the upper right near the wafer edge.

If one of the last two dice is not adequate, move one die away. You rough align and fine align by following the instructions in the Find ie pitch values window. Your new pitch values appear in their respective fields in the Die Setup window. These pitch values also appear in the Wafer control parameters window.

Save button

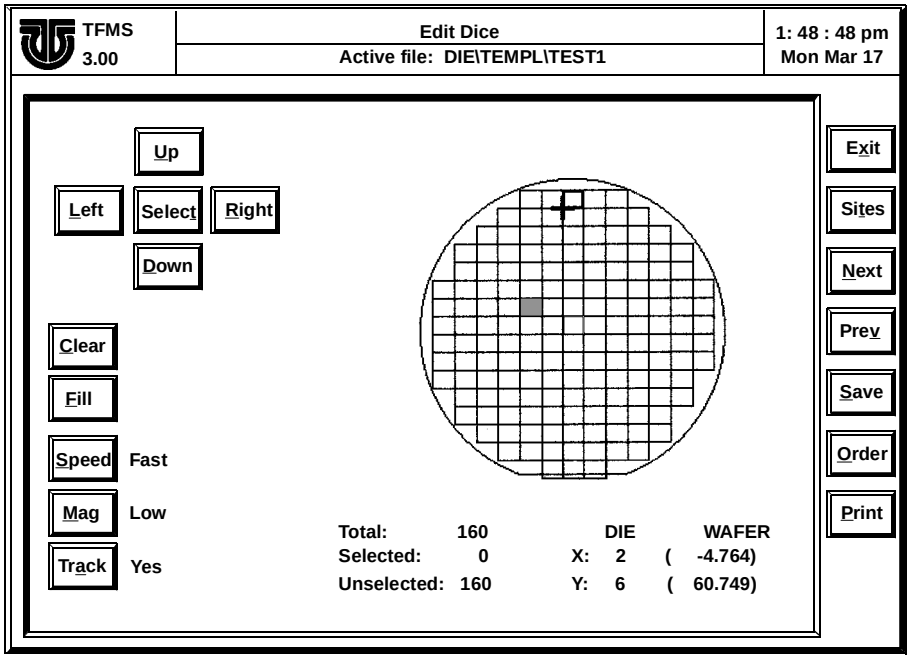
When you select the *Save* button in the Die Setup window, a confirmation dialog box gives you the option of saving or canceling your entries.

4.6.2 Dice and sites

When you select *Dice and sites* in Die Template menu, the Edit Dice window appears displaying some new buttons and a wafer map with a grid of dice, as shown in the example in Figure 4.52.

A blue crosshair and an outlined die appear on the wafer map, showing the approximate position of the laser on the wafer. The red die (shaded die on wafer map in figure) represents the reference die. If all the dice on a wafer are not identical (groups), some of the dice appear in gray. In this example, we'll assume that the wafer has dice that are all identical (no groups).

Figure 4.52 Edit Dice window



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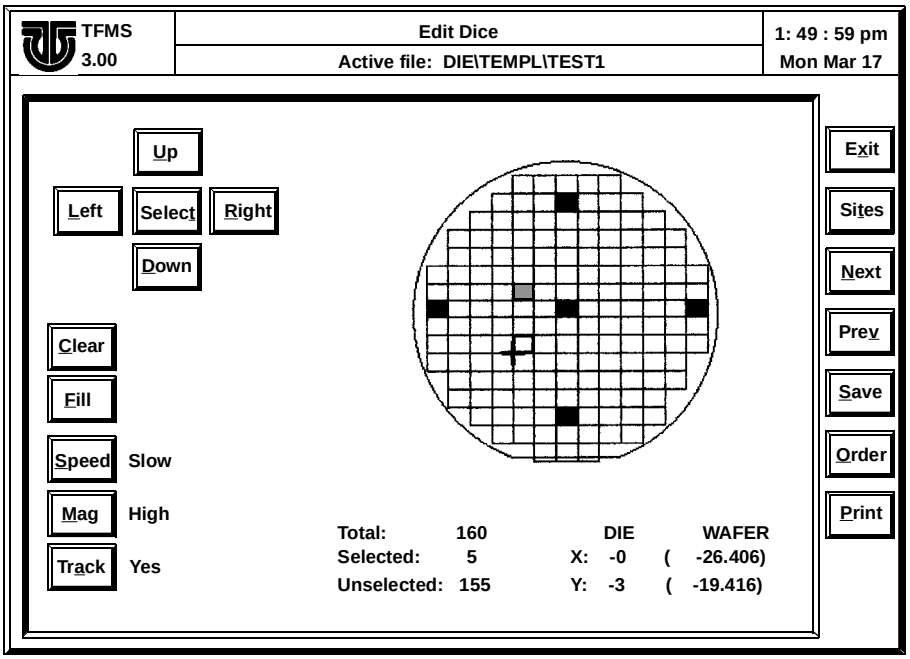
When you open this window, if the laser spot is at the intersection of four dice (corner of one die), you should use the trackball to re-position the laser spot within a die. You can select a die on the wafer map with the light pen. The stages move to your selected die, which appears on the sample viewing monitor, and you see the outline and the crosshair on the wafer map move to that die.

You must select the same die again to select it for your measurement. Your selected die appears in green. If you select the reference die, it appears in blue. During a measurement, the system only measures the selected green or blue dice.

Alternatively, you can press twice (double-click) on a die with the light pen to select it for a measurement or use the five buttons at the upper left side of the window (*Up*, *Down*, *Left*, *Right*, *Select*) to move toward a die and then select it for a measurement. You can deselect a selected die by selecting it again with the light pen or the *Select* button. Figure 4.53 shows five dice selected for a measurement.

Figure 4.53 Edit Dice window (after selecting five dice)



If the dice are not identical and you taught the stepper group dimensions, you must select dice that are in the same position relative to the stepper group origin. These dice appear in gray on the wafer map, and are located at the lower left corners (origins) of the stepper groups and include the reference die.

Prev button

When you select the *Prev* button, the blue crosshair and the outline move to the previously selected die. The first time you use the *Prev* button, the blue crosshair and outline move directly to the first die selected.

Next button

When you select the *Next* button, the blue crosshair and outline move to the next die selected. If you select the *Next* button when the crosshair is in the last die or if you select the *Prev* button with the crosshair on the first die, the crosshair disappears.

Order button

The system measures the (green) dice in the order in which you select them.

When you select the *Order* button, a confirmation dialog box appears, as shown in Figure 4.54. When you select *Ok* in the dialog box, the system reorders the dice in the most time efficient sequence and then another dialog box appears informing you that the reordering of the dice was successful, as shown in Figure 4.55. When you complete a successful reordering setup, the system measures the dice in a serpentine style at run time. The measurement sequence starts at the top of the wafer map, moves to the right, then down to the next row where a selected die is located, then moves to the left, etc.

Figure 4.54 Reordering confirmation dialog box

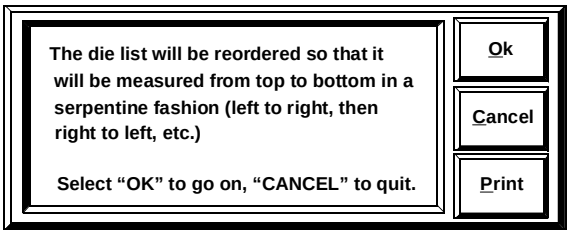

The die list will be reordered so that it will be measured from top to bottom in a serpentine fashion (left to right, then right to left, etc.)
Select “OK” to go on, “CANCEL” to quit.
Ok
Cancel
Print

Figure 4.55 Successful reordering dialog box

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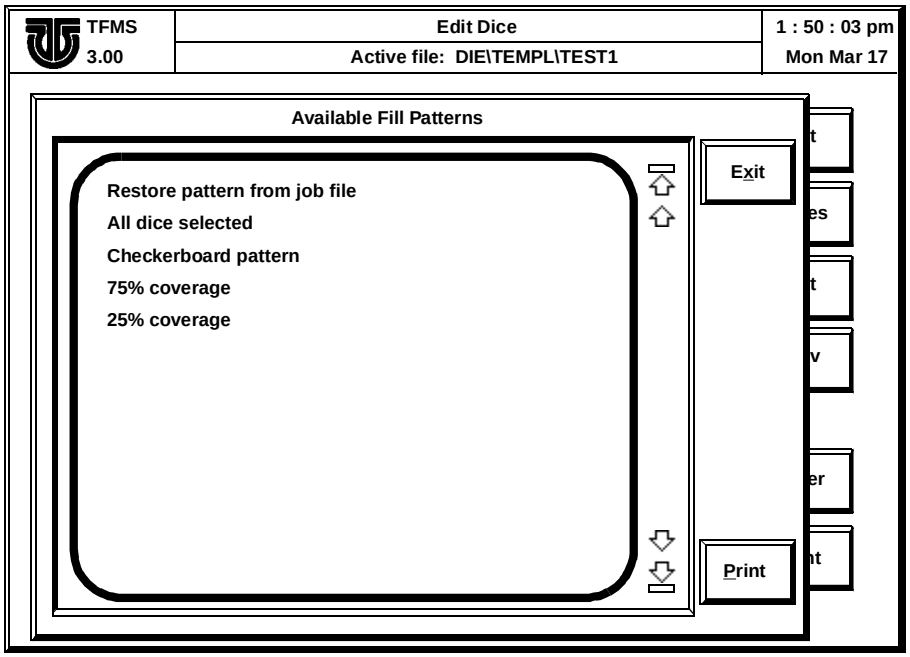
Clear button

When you select the *Clear* button in the Edit Dice window, a confirmation dialog box appears that asks you if you want to delete the selected dice. If you select *Ok* in the dialog box, the system deletes all the selected dice.

Fill button

When you select the *Fill* button in the Edit Dice window, the Available Fill Patterns window appears with five options: *Restore pattern from job file*, *All dice selected*, *Checkerboard pattern*, *75% coverage*, and *25% coverage*, as shown in Figure 4.56. When you select one of these options, the system fills the wafer map according to your selection. You must save your changes by selecting the *Save* button in the Edit Dice window before you can use the *Restore pattern from job file* option.

Figure 4.56 Available Fill Patterns window



Track button

When you set the *Track* button to *Yes* in the Edit Dice window, the stages move to any die you select on the wafer map. The selected die appears on the sample viewing monitor, so you can verify that you selected an adequate die. If you select *No* with the *Track* button, the stages do not move when you select dice. You can

select dice faster if the stages don't move. If you change the *Track* button from *No* to *Yes*, the stages move to the last die selected.

Save button

When you select the *Save* button in the Edit Dice window, a confirmation dialog box gives you the option of saving or canceling your Die Setup and Dice and Sites entries.

Sites button

When you select the *Sites* button in the Edit Dice window, the Edit Sites window appears, as shown in Figure 4.57. In this window, you can define the measurement sites within each selected die. A Function menu appears at the upper left side of the window, the Site list is empty, and you see a Site map representing a die at the bottom of the window. The *Speed* and *Mag* buttons operate as usual. The *VP Mode* and *Video* buttons operate as they do in the Teach Mask Alignment Sites window (Mask teach), described earlier in this section for custom templates.The Function menu and the *Param* button operate the same as they do in the Teach Measurement Sites window (Site teach). In addition, you see a *Dice* button in the window's right margin. The sites taught in one die are measured in each of the selected dice. When there are no sites taught, the Site list is empty. If you want to add a site, select *Add* in the Function menu. Model numbers begin with 1 (instead of 2 for custom templates). If a wafer is not loaded, the *Models*, *Search*, *Go to*, and *Clear* options are non-selectable.

Dice button

When you select this button, the Edit Dice window appears, as shown earlier in Figure 4.49.

Below the Function menu, you see following coordinates displayed:

DIE (die coordinates): The currently selected die's coordinates in die units, relative to the reference die.

WID (within die coordinates) : The site coordinates of the site in the die area relative to the die origin (lower left corner), in millimeters.

Save button: When you select the *Save* button in the Edit Sites window, a confirmation dialog box gives you the option of saving or canceling your Die Setup and Dice and Sites entries.

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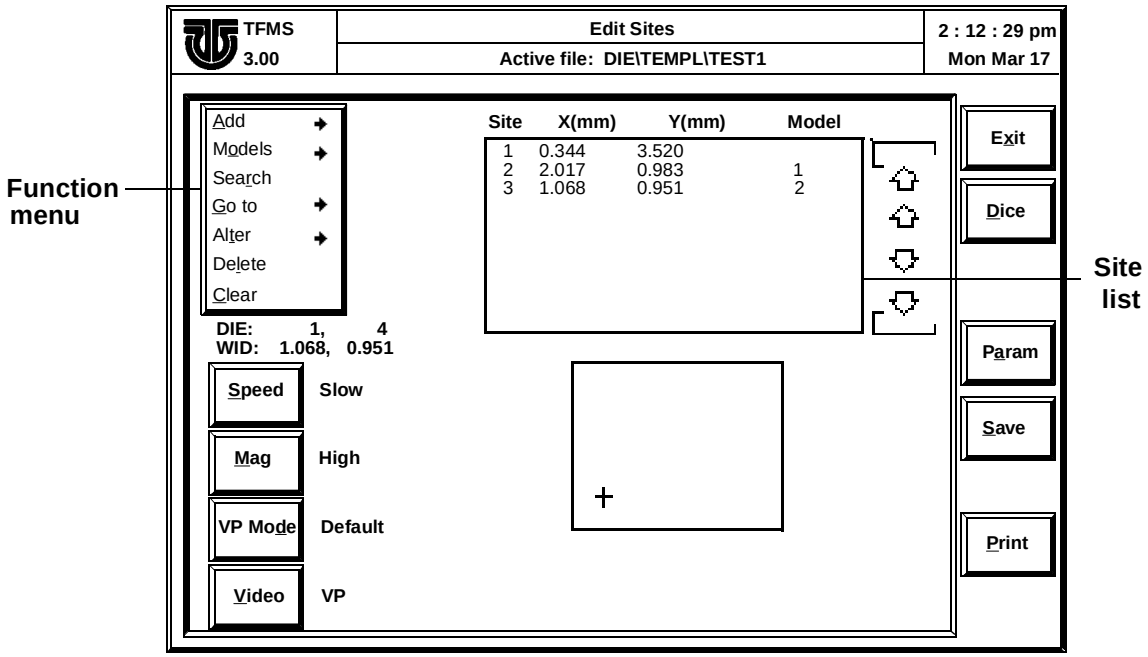
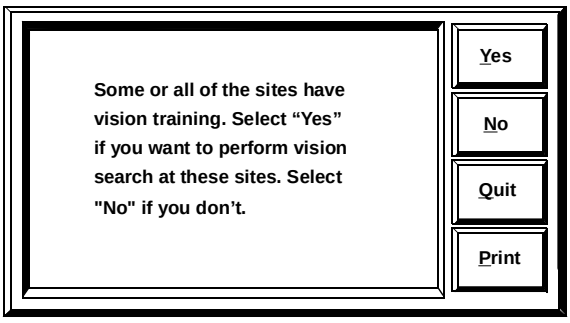
Figure 4.57 Edit Sites window



4.6.3 Site visit

When you select *Site visit* in the Die template menu (with a site model trained), a dialog box asks if you want to perform vision (model) search, as shown in Figure 4.58. If there are no models trained, this dialog box does not appear.

Figure 4.58 Perform vision search dialog box


Some or all of the sites have vision training. Select “Yes” if you want to perform vision search at these sites. Select "No" if you don’t.
Yes
No
Quit
Print

When you select *Yes* or *No* in the above dialog box, or no models are trained, a dialog box asks whether you want the visit to be performed in high magnification

or in high magnification and then low magnification (the VP does not perform a vision search in low magnification). After making your selection, the Site visit window appears. This window is identical to the *Custom template*/*Site visit* window, described earlier in this section.

The system applies pattern recognition (VP search) to the model for each site with an associated saved model before positioning the stages at the measurement site.

During the Site visit operation, the TFMS monitor displays the sites and dice that the VP visits on wafer and die maps, and you see the following sequence of messages appear briefly in the Status line:

- *Measuring die 1 of 5, site 1 of 2*
- *Measuring die 1 of 5, site 2 of 2*
- *Applying pattern recognition correction to site 2*

As the VP visits each site, the sample viewing monitor displays an outline of the spatial averaging area and for spectrometer measurements, the spectrometer reading area.

The system does not perform any measurements during the above sequence.

After completion of the Site visit operation, the Die template menu reappears.

4.7 LIBRARY MENU

When you select *Setup*/*Library*, the Library menu appears, as shown in Figure 4.59.

This menu displays two template library options, *Custom Template* and *Die Template*. For a description of the *Film* option, see Section 3. For a description of the System Expert level *Materials* option, see Section 6.

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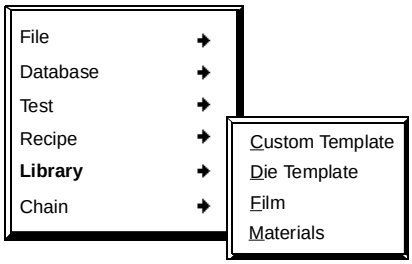
Figure 4.59 Library menu



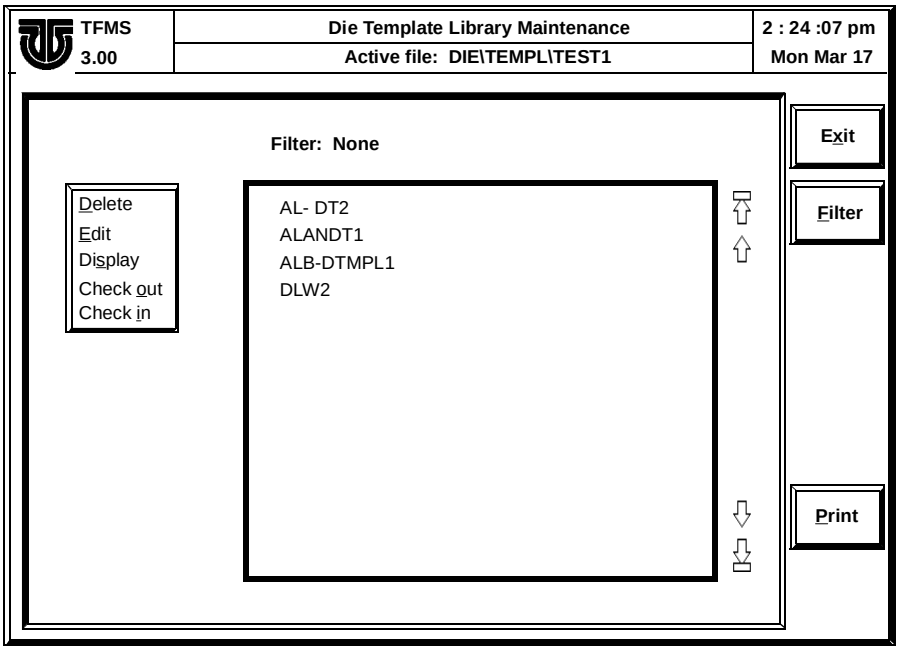
When you select *Die template* or *Custom template*, the corresponding Library Maintenance window appears, as shown in the example in Figure 4.60 for die templates. This window displays a list of all the available die templates or custom templates saved in the respective library.

The following description uses the Die Template Library Maintenance window as an example. All the die template and custom template library functions operate identically.

You can add a die template or a custom template to the Die template or Custom template library so it is accessible to other users who can copy it into their job files. You can also copy a library template into your job file, display a template and its related data, and edit or delete any of your template entries. When you open either of the library maintenance windows, you see a Function menu at the upper left side of the window, the Die template or Custom template list appears in alphabetical order in the center, and a *Filter* button appears in the right margin.

4.7.1 Custom template, Die template

Figure 4.60 Library Maintenance window (die template)



Delete

When you select a template in the Die Template or Custom Template Library Maintenance window, and then select *Delete* in the Function menu, a confirmation dialog box appears asking whether you want to delete the selected template. If you don't have deletion privileges, a dialog box informs you of this.

Edit

When you select a template and then select *Edit* in the Function menu, the Edit Template Library Information window appears, where you can change the name and/or keywords for the selected template. If you do not have editing privileges, a message informs you of this.

Display

When you select a template and then select *Display* in the Function menu, the Library Entry window appears, as shown in the example in Figure 4.61 for a die template. This window displays the selected die template or custom template and

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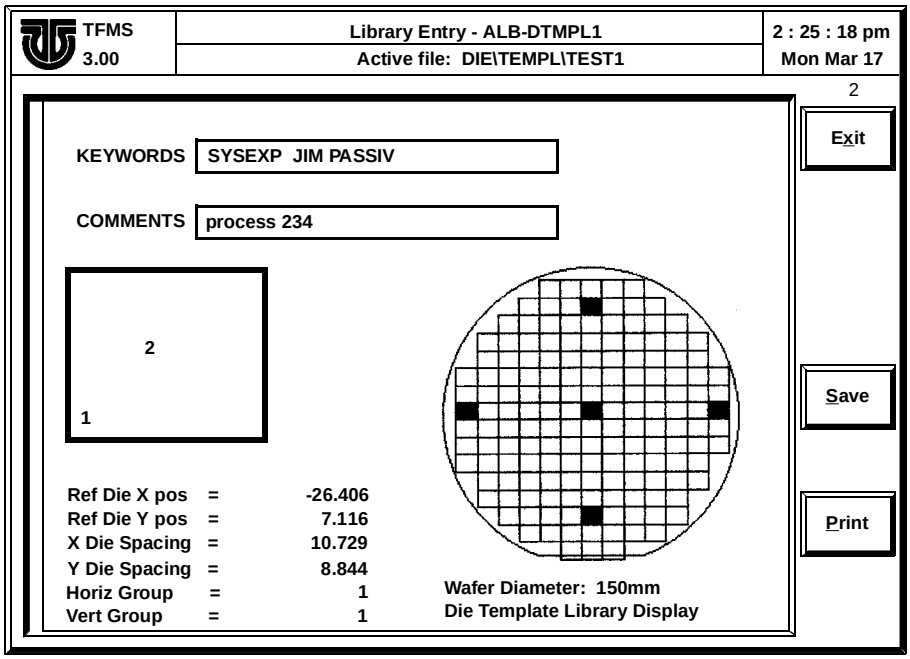
related data. You also see *Keywords* and *Comments* fields at the top of the window. In this window, you can look at the displayed template and decide if you want to use it to replace the one in your job file.

Figure 4.61 Library Entry window (die template)



Keywords :This field displays the User ID and any other characters entered by the user who checked in the template. These characters are called keywords. When you select the *Filter* button and enter a keyword, a list of templates associated with that keyword appear.The *Filter* button is described in detail on the next page.

When you select the *Keywords* field in the Library Entry window, a keyboard window appears displaying your User ID as the default keyword. You can enter a new keyword by typing a space followed by one or more words (e.g., JIM PASSIV) after the User ID, and then selecting the *Enter* button in the keyboard window. Alternatively, you can delete the User ID and replace it with some new keywords.The Library Entry window reappears with your new keywords displayed in the *Keywords* field. You must have the required access privileges to modify keywords and comments.

Comments:The *Comments* field displays optional information entered by the user (i.e., the type of pattern, sites, or dice that are saved in the job file's die template).

When you select the *Comments* field, a keyboard window appears where you can enter any comments you like.

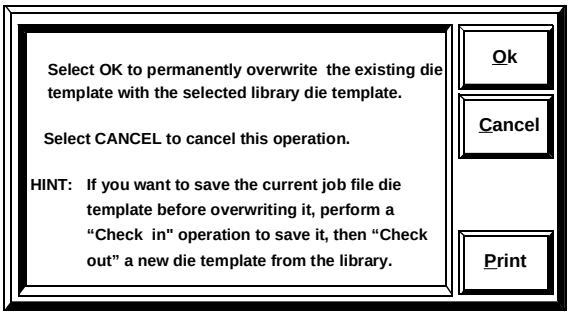
Filter button

When you select the *Filter* button in the Die Template or Custom template Library Maintenance window, a keyboard window appears. When you enter a keyword in this keyboard window (e.g., JIM), the template list only displays the template(s) associated with that keyword. After using the *Filter* button, you can view all the templates by selecting the *Filter* button again. A keyboard window appears where you select the *Enter* button without making an entry. The Die Template or Custom Library Maintenance window reappears with all of the templates displayed in the template list.

Check out

You can copy or " Check out" a library template into a job file setup for a Die template or Custom template measurement. When you select the desired template in the template list and then select *Check out* in the Function menu, the Check out dialog box appears, as shown in Figure 4.62.

Figure 4.62 Check out dialog box (die template)


Select OK to permanently overwrite the existing die template with the selected library die template.
Select CANCEL to cancel this operation.
HINT: If you want to save the current job file die template before overwriting it, perform a "Check in" operation to save it, then "Check out" a new die template from the library.
Ok
Cancel
Print

If you select *Ok* in the dialog box, the system copies the selected template into your job file, overwriting any existing template. If you want to save your job file's current template, add it to the library by performing a Check in operation (described next) before checking out the new template. The library template you check out is your private copy and it includes mask alignment, pitch, dice, and sites. You can use the template as it is or alter it and then use it. You can add the altered version to the corresponding template library under a different name.

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Check in

You can add or "Check in" the active job file's template to the library by selecting *Check in* the Function menu. A keyboard window appears where you can enter a unique name for your die template using up to 30 characters. After you enter the name of your die template or custom template, it appears in the corresponding template list.

You cannot create and use a die template or custom template unless a job file is open.

4.7.2 Display control menu (die template measurements)

If you teach mask alignment for a custom template, it is retained when you change the measurement type to a custom template.

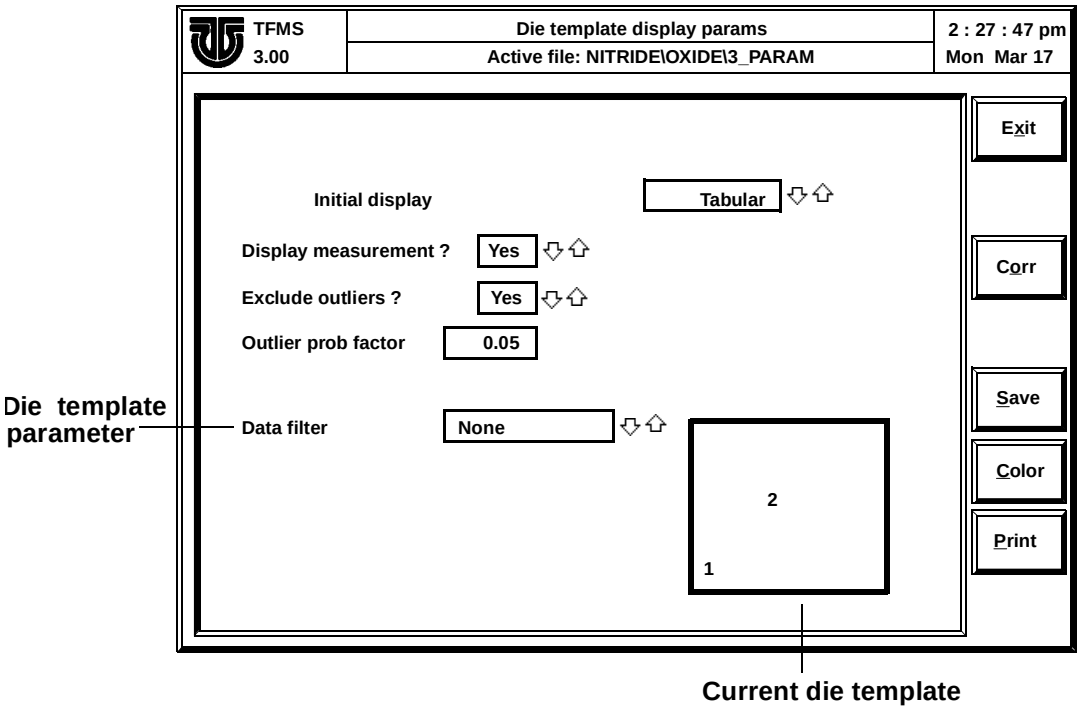
When you select *Setup*/*Recipe*/*Data output*/*Display control* for a die template, the Die template display parameters window appears, as shown in Figure 4.63. In addition to the usual display parameters, you see a *Data filter* parameter and the current die template is displayed at the bottom right side of the window. This window also appears when you select the *Param* button in a die template measurement results window.

Data filter

This parameter allows you to create die template displays and printouts that sort the wafer measurement results by the sites located within each of the measured dice. This demonstrates the loading uniformity effects across the wafer. You can view a die template data filter display in the measurement results window that appears after a measurement or by selecting *Display*/*Saved measurement* and selecting a filtered die template. You can view the data filter measurement results as a tabular display or a map display (contour or 3-D). For a data filter, the system only modifies the display or printout, retaining the raw data (measurement points) in the database. When you select the *Data filter* field, four options appear, *None*, *Die average*, *Single point*, and *Difference (A-B)*.

None: Specifies no data filter.

Figure 4.63 Die template display parameters window



Die average: Specifies that the system calculates and displays the average measurement results of all the sites within each measured die.

Single point: Specifies that the system pre-processes data for a selected point within each measured die. If you select this option, another parameter appears below the *Data filter* field,
Point to Display. In the *Point to Display* field, you enter the number of the desired measurement site in the current die template.

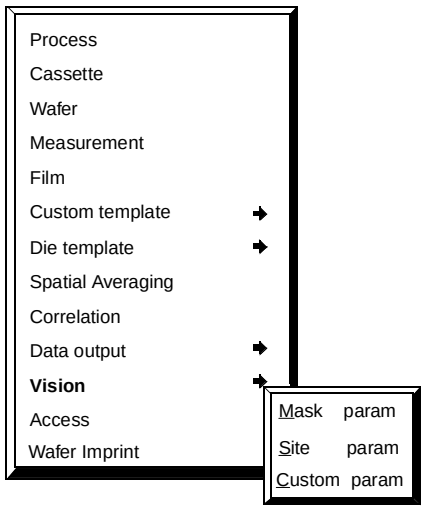
Difference (A-B): Specifies that the system pre-processes data as the difference between points A-B within each measured die. If you select this option, two more parameters appear below the *Data filter* field, *Diff-Point A* and *Diff-Point B.* In these fields, you enter the numbers of the measured sites in the current die template that the system uses for the difference calculation (e.g., for site 1 - site 2, enter 1 for Diff-PointA and 2 for Diff-PointB).

All of the affected die template windows and printouts indicate the current data filter selection.

4.8 VISION MENU

When you select *Vision* in the Recipe menu, the Vision parameters menu appears, as shown in Figure 4.64. The options in this menu open VP parameter windows where you can configure parameters for different types of pattern recognition tasks.

Figure 4.64 Vision parameters menu



4.8.1 Mask param

When you select this option, the Mask Teach VP Parameters window appears, as shown earlier in this section in Figure 4.5. In this window, you can set up the mask alignment pattern recognition parameters, which are applicable for both custom templates and die templates.

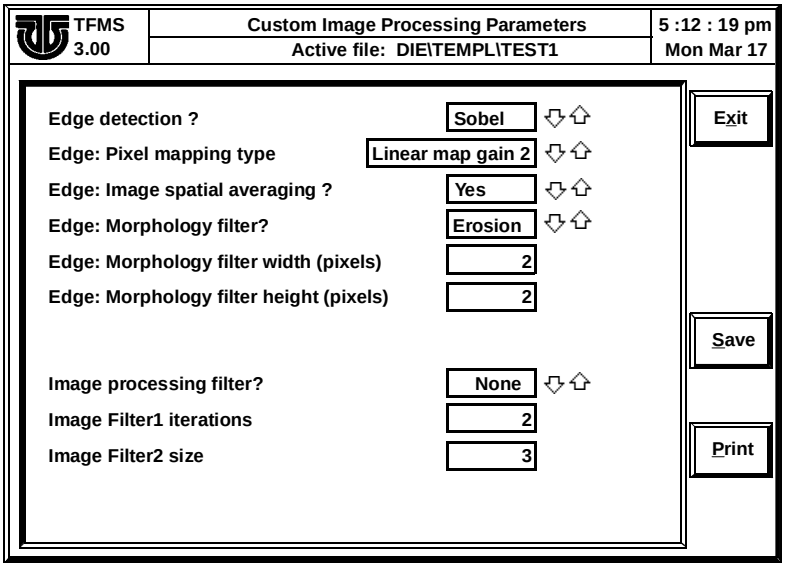
4.8.2 Site param

When you select this option, the Site Teach VP Parameters window appears, as shown earlier in this section in Figure 4.22. In this window, you can set up the site alignment pattern recognition parameters, which are applicable for both custom templates and die templates.

4.8.3 Custom param

When you select *Custom param* in the Vision parameters menu, the Custom Image Processing Parameters window appears, as shown in Figure 4.65. These parameters specify various aspects of image processing that occur during the training and searching steps. These default entries correspond to the *Edge 1* option (*Mode-Deflt, Edge, Custom* field in Mask /Site Teach VP Parameter windows and *VP Mode* button).

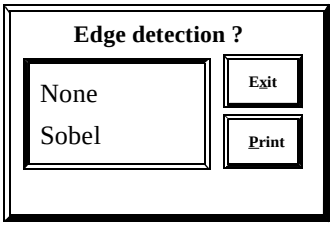
Figure 4.65 Custom Image Processing Parameters window



Edge detection?

Specifies whether the VP detects and enhances the edges of a feature to identify its shape. When you select this field, a pop-up menu appears with two options, as shown in Figure 4.66.

Figure 4.66 Edge detection pop-up menu



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None :Uses all the default gray levels and does not perform edge enhancement.

Sobel :Performs edge enhancement.

Edge: pixel mapping type

Specifies (along with the other custom image processing parameters) the level of enhancement of feature edges (transition between dark and light areas). When you can select the *Edge pixel mapping type* field, a pop-up menu appears with the following options that correspond to seven levels of contrast enhancement at the feature edges.

Linear map gain 2 :Corresponds to Edge 1.

Linear map gain 4 :Applies contrast enhancement at a level between Edge 1 and Edge 2.

Linear map gain 8 :Corresponds to Edge 2.

Linear map gain 12:Applies a gain factor of 12.

Linear map gain 16:Applies a gain factor of 16.

Linear map gain 20:Applies a gain factor of 20.

Linear map gain 25:Applies a gain factor of 25, corresponding to an Edge 3 VP mode.

Edge: Image spatial averaging?

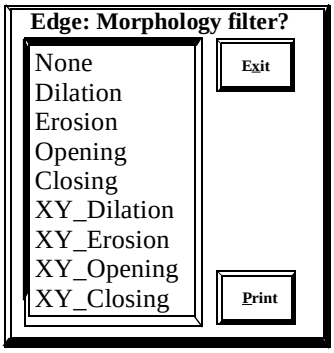
Specifies whether or not to perform image averaging during edge detection. Image averaging smooths the image during the train and search operations. You should select *Yes* (the default value) for this parameter.

Edge: Morphology filter?

Specifies a morphology type, which is an image processing operation that affects the edges of objects within an image. Morphology is only used during edge

detection. When you select this field, a pop-up menu appears with nine options, as shown in Figure 4.67. In most cases, you should use the *None* or *Erosion* options.

Figure 4.67 Morphology filter pop-up menu



None:Morphology is not used. This results in thinner edge lines, which is useful for closely spaced features.

Dilation:A morphological operation that enlarges light objects and shrinks dark objects in an image. For edge detection, this operation thins dark lines.

Erosion :A morphological operation that shrinks light objects and enlarges dark objects in an image. For edge detection, this operation thickens dark lines. *Erosion* is the default and is Therma-Wave's recommended selection for edge detection. The system uses Erosion in
Edge 1 and Edge 2.

Opening :A two-step morphological operation in which erosion is followed by dilation. This combination eliminates light details (lines, holes, etc.) in dark objects and smooths the edges of dark objects. For edge detection, this operation smooths and fills in dark areas.

Closing :A two-step morphological operation in which dilation is followed by erosion. This combination eliminates dark details (lines, islands, etc.) in light objects and smoothes the edges of light objects. For edge detection, this operation smooths and fills in light areas.

XY_Dilation:The same as the Dilation option with emphasis on XY directional features.

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XY_Erosion: The same as the Erosion option with emphasis on XY directional features.

XY_Opening: The same as the Opening option with emphasis on XY directional features.

XY_Closing: The same as the Closing option with emphasis on XY directional features. The VP system uses this option in Edge 3.

Edge: Morphology filter width (pixels)
Edge: Morphology filter height (pixels)

Specify the number of pixels around a central pixel that are affected by a morphological operation (e.g. dilation, erosion, opening, closing). They define the width (number of horizontal pixels) and height (number of vertical pixels) of a morphological element. The Edge 3 VP mode uses a non-symmetrical width and height, e.g., width of 2 pixels, height of 7 pixels. When you enter *1* for each of these parameters, it has the same affect as selecting *None* in the *Edge Morphology filter* field.

Image processing filter?

This parameter applies a two-dimensional filter array to an image. This smooths the image, reducing background noise. You can select from the following three options.

None : Disables the image processing filter.

Filter1: Reduces high frequency noise, while retaining low frequency features. The Edge 3 VP mode, uses Filter 1.

Filter 2: Smooths noise patterns, while retaining edge details and sharpness.

You can use either Filter1 or Filter2 for edge detection. Typically, you can use Filter1 to reducebackground noise, unless you need to retain the edge details. If you use Filter2, the image processing operation requires more time.

Image Filter1 iterations

Specifies the number of kernel iterations applied to an image when Filter1 is enabled. The range is 2-5. Edge 3 uses an iteration of 2.

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Image Filter2 size

Specifies the size of the kernel applied to an image when Filter2 is enabled. The range is 3-9.

4.9 TROUBLESHOOTING

This section provides a troubleshooting quick reference guide to help you solve problems you may encounter while using the Opti-Probe's vision processing system. If you cannot fix a problem using the recommended solutions, call Therma-Wave Applications Staff.

Communication failures

Symptom	*Possible Cause(s)*	*Solution*
One or more of the following error messages appears: 0x93080002 No response from VP 0x93080003 Incomplete response from VP 0x93080011 VP communications error	The communications link to the vision processor is lost.	1. Try the operation again. Sometimes noise corrupts data communication. But this should not occur after a second attempt. 2. Re-initialize the vision processor (*Machine*/*Initialize VP*) and then try again. 3. Refer to "Hardware problems" later in this section.

Poor model selection

Symptom	*Possible Cause(s)*	*Solution*
One or more of the following error messages appears: 0x93080008 VP search failed 0x9308000B VP low shape score 0x9308000C VP low confidence score 0x93080012 VP pattern not unique 0x93080015 VP train model failed	The trained model is either not unique, not repeatable, or not present in the field of view.	Perform a Mask evaluate or Site evaluate operation, whichever is appropriate, as described earlier in this section. Refer to the "Using the Mask (site) evaluation function" tutorial in your "Getting Started" manual.

Troubleshooting mask alignment problems

Figure 4.68 shows how the VP system performs a successful mask alignment. If the search for site 3 does not succeed because site 3 is too close to site 1, enter a distance for site 1 - site 2 that does not exceed one die pitch and repeat the mask teach operation. If the search fails again, select another pattern to use as a model for site 1, or use the *Train/Search test model* function in the Mask evaluation window to optimize the search for the selected sites at three locations on the wafer. If the contrast is poor or the color/shades of gray vary across the wafer, you can use one of the edge enhancement options. If the mask teach operation is successful but the mask alignment fails (e.g., on another wafer), you can re-open the Mask Teach VP Parameters window, lower the Train selectivity entry, and teach mask alignment again. You may also have to enter a lower minimum shape score.

Wafer variation

Some wafer processes result in thickness and/or composition nonuniformity from region to region within the same wafer or from wafer to wafer. Although the wafer's geometric pattern remains the same, the color can change. The VP perceives the change in color as a change in light intensity or gray level. As a result, the VP may recognize the wafer's pattern at some, but not all, sites.

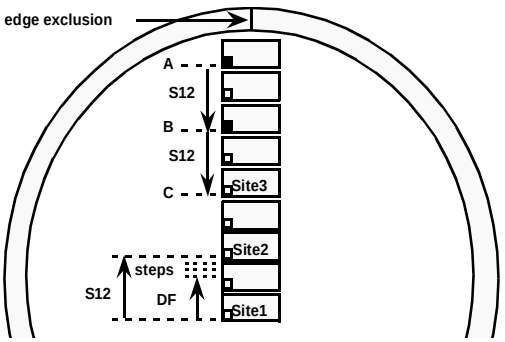
Sometimes the variation within a wafer affects both the inner wafer region (close to the center) and the outer wafer region (close to the edge). If this happens, you should try to contain the mask alignment sites and generic measurement sites to the inner wafer region where the variation is usually less severe. For mask

alignment sites, increase the mask edge exclusion by 1, 2, or 3 die size units to keep the third site away from the edge of the wafer.

If you anticipate wafer to wafer process variations, or you cannot contain the sites to the inner wafer region, use edge detection during the model learning process. This directs the VP to rely on the edges (outlines) of the patterns rather than the colors (or gray levels) of the pattern, which are subject to change. To enable edge detection, use the (*Mask teach*, *Mask evaluate*, *Site teach*, and/or *Site evaluate*) *Edge* button. You can enable edge detection separately for mask and site alignment. Remember that edge detection slows down the pattern recognition process, so use it only when necessary. If you expect wafer to wafer color variations to be the rule rather than the exception at your facility, ask Therma-Wave Applications Staff to set up edge detection as the default for any newly created job file.

Figure 4.68 Troubleshooting mask alignment problems

1. The VP learns Site 1 pattern (model)
2. The stage moves up by the default Site1-Site2 distance (DF) but the VP cannot find the same pattern, so the stage moves up in 0.7mm steps until the VP finds that pattern at site 2. S12 = new Site1-Site2 distance
3. The stage moves up by N x S12 to find a Site3 closest to edge of wafer (minus edge exclusion distance). If VP finds pattern at location A, this location becomes Site3.
4. If VP does not find the pattern at location A, the stage moves down in S12 increments until the VP finds the pattern.
5. In this example, the VP's search fails at locations A and B, and succeeds at location C (Site 3), but the Mask teach operation fails because Site3 is too close to Site 1.



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Following are some additional troubleshooting procedures relating to wafer variation:

Symptom	*Possible Cause(s)*	*Solution*
The following error message appears during mask alignment: 0x93080008 VP search failed 0x9308000B VP low shape score	Within wafer variation.	1. Re-teach mask alignment site(s), especially site 3, to contain the alignment to the inner wafer region. 2. Use edge detection for mask alignment. 3. If the model is unique, it may be possible to lower the min. shape score. Refer to the "Optimizing the acceptance threshold" tutorial in your "Getting Started" manual.
The following error message appears during measurement site alignment: 0x93080008 VP search failed 0x9308000B VP low shape score	Within wafer variation.	1. In custom templates, use a generic site model for points closer to the center of the wafer, and unique site models for outer points. 2. Use edge detection for site alignment. 3. Follow step 3 above.
The following error message appears during mask or site alignment: 0x93080008 VP search failed 0x9308000B VP low shape score	Wafer to wafer process variation.	1. Use edge detection for mask and/or site teach. 2. Follow step 3 above.

Hardware Problems

Symptom	*Possible Cause(s)*	*Solution*
No white light image of wafer.	Burnt light bulb.	Contact system manager or other on-site trained maintenance personnel to replace the light bulb.
Hardware error message, or no response from vision processor after trying an operation two or more times.	System requires re-initialization.	1. Restart(*Machine*/*Restart*); retry the operation that failed. 2. Unload the wafer, turnoff the power, and re-boot the system.
Hardware problems persist after reinitializing system.	Loose cable or other hardware failure.	Call Therma-Wave.

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5

DUV FUNCTIONS

Contents

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- UV in the Opti-Probe 5-3
- Setting up a UV reflectivity measurement 5-7
- Display menu 5-10
- Performing and displaying UV measurements 5-15

This section summarizes current UV technology and explains how the Opti-Probe Models 2600DUV/2600DUVI meet semiconductor industry requirements in this advancing area. It also includes a complete description of all the UV related functions provided in these systems.

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5.1 CURRENT TRENDS/JUSTIFICATION FOR UV TECHNOLOGY

The continued push to drive device dimensions into the sub-micron regime has forced semiconductor lithography processes to shift the stepper exposure wavelength from g-line (436nm) to i-line (365nm) to deep UV (248nm) and eventually, to wavelengths as low as 193nm. The move toward DUV increases the problem of controlling the interference effects caused by interfacial reflections, which are compounded at these shorter wavelengths. These reflections undercut the photoresist pattern at the interface between the resist and the substrate film. Interference conditions are apparent from reflectance versus resist thickness swing curves. The semiconductor industry is using anti-reflective coatings (ARC's) like TiN to help control these interfacial reflections. Both top and bottom anti-reflective coatings are used, depending on the conditions requiring control. The ability to measure reflectivity vs. wavelength is critical in characterizing these ARC's.

5.2 UV IN THE OPTI-PROBE

The Opti-Probe 2600DUV and 2600DUVI are powerful film thickness measurement systems that combine multiple technologies to measure most semiconductor films with a high degree of accuracy and precision. Beam profile reflectometry (BPR) measures reflectivity as a function of angle of incidence for two mutually perpendicular (s&p) polarization directions. Spectrometry measures reflectivity as a function of wavelength. Beam profile ellipsometry (BPE) measures phase shift between two polarization directions of light reflected from the film and substrate.

The spectrometer's visible component measures the wafer reflectance over the 470nm to 800nm range. The Opti-Probe uses the results of this measurement to calculate film thickness. The UV monochrometer component measures the wafer reflectance over the 190nm to 650nm range. Following is a description of the Opti-Probe's DUV measurement capabilities.

The Opti-Probe DUV models extend the system's measurement capabilities as follows:

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1. Restricts the UV spectral data range to the region where the underlying layer in a multi-layer film stack is highly absorbing. This allows you to de-couple the optical effects of the transparent and opaque regions below and measure the layer(s) above the absorbing layer. For example, you can measure the top Oxide layer in an OPO film stack by using UV spectral data in the region where the Poly layer is effectively the substrate. This operation is not possible on non-UV systems, which use wavelengths in the visible and near IR region of the spectrum.

2. Uses the UV spectral data in a fit, improving the measurement precision and extending the measurement performance range. For example, the DUV system can improve precision and repeatability measurements of thin ONO. As a result, the DUV system performs more precise measurements of thinner ONO film stacks than non-UV systems.

3. Measures optical parameters at wavelengths other than the laser wavelength. When you select a different wavelength, all of the reported measurement values for index (n) and extinction (k) correspond to the specified dispersion wavelength value. This can be very useful when characterizing anti-reflective coating material, where you can use the n and k information at the stepper wavelength (in addition to thickness) to develop the proper material with the correct combination of t, n, and k, minimizing the reflectance of the substrate and increasing line-width control.

To accurately fit UV spectral data and measure the optical parameters down into the UV region, you must characterize the dispersion of each material properly (including the substrate and the Si reference). For non-UV measurements, the Cauchy representation for optical dispersion is adequate because the visible spectrum is a great distance from the absorbing region in most materials. However, in the UV spectrum, many materials are highly absorbing, and the system requires a dispersion characterization other than the Cauchy representation. The Opti-Probe provides three additional dispersion characterizations, a Lookup Table that represents the optical dispersion as a list of n and k values for different wavelengths, a Critical Point or oscillator model that provides resonant enhancement of the material's polarization, and an Effective Medium, which allows you to create a material with up to three different component materials, each with their own characterization. These are System Expert level parameters and are not covered in this section. For a complete description of these and other advanced UV-related parameters, see the next section in this manual, "System Expert Functions."

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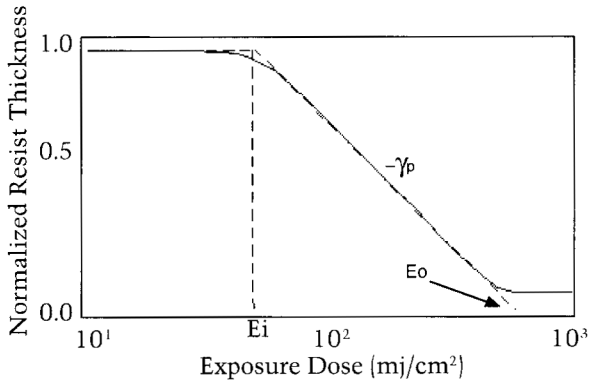
5.2.1 UV application and photoresist characterization

Anti-reflective coatings work by reducing the intensity of the reflected light at the top anti-reflective coating interface or at the resist /substrate boundary for bottom antireflective coatings. The R_{max}/R_{min} reflectance swing ratio influences the line-width control, exerting a greater influence as the exposure wavelength decreases. This is applied on the Opti-Probe when the system obtains the optimal thickness of an ARC by measuring reflectivity vs. wavelength for several ARC thicknesses, finding the minimal reflectivity at the stepper wavelength.

You can also use swing curves to analyze the performance of photoresist in terms of its impact on line-width control. You plot these curves to determine the photoresist exposure dose required to reduce the thickness to zero during the resist development process. This exposure dose is termed E_0, the dose to clear (sometimes called sensitivity), which is determined by measuring resist film thickness after development for various stepper exposures and then plotting the result. This is called a gamma curve, which is shown in the example in Figure 5.1 for the commonly used positive photoresist. The slope of this curve, γ_p, also provides useful information about the contrast or gamma of the photoresist. In general, γ_p is expressed as:

Figure 5.1 Gamma curve for typical positive resist

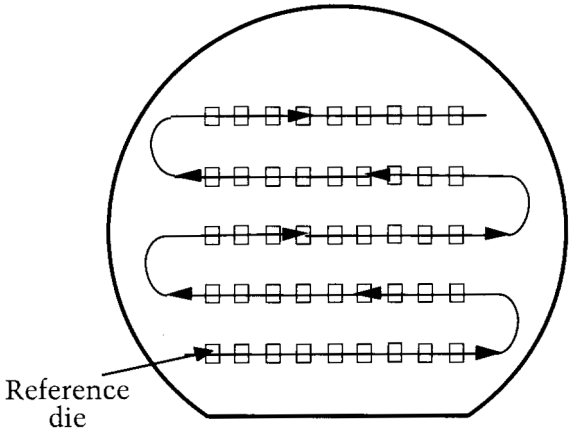


where E_i = dose when resist first dissolved and E_0 dose to clear.

To generate a gamma curve, you expose a resist coated wafer to increasing exposures by the stepper, typically in a serpentine pattern, as shown in the example

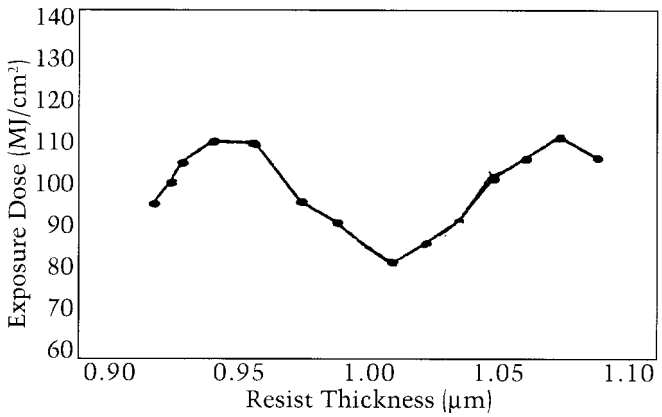
in Figure 5.2. In this example, each pad is exposed at a different dose. After development, the system measures the thickness of remaining resist.

Figure 5.2 Serpentine exposure pattern used to generate (row) gamma curves



By arranging the exposure array in either a row (as shown in Figure 5.2) or column format, you can obtain more than one gamma curve for each wafer. For example, in a typical exposure 40 x 40 array, you can obtain up to 40 gamma curves with 40 measurement points for each curve. This is how the system obtains mean values for each of the above parameters within a wafer. After exposing and developing a series of wafers with a range of resist thicknesses, you can obtain a swing curve that shows the dose required to clear the resist thickness upon exposure, as a function of the resist thickness. This type of plot is shown in Figure 5.3.

Figure 5.3 Exposure dose versus film thickness



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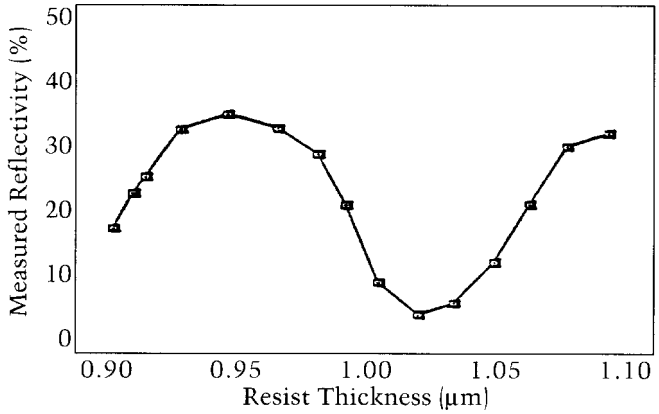
It is possible to obtain a similar curve by plotting resist reflectivity versus resist thickness at the stepper exposure wavelength, as shown in the example in Figure 5.4.

Figure 5.4 Reflectivity versus resist thickness



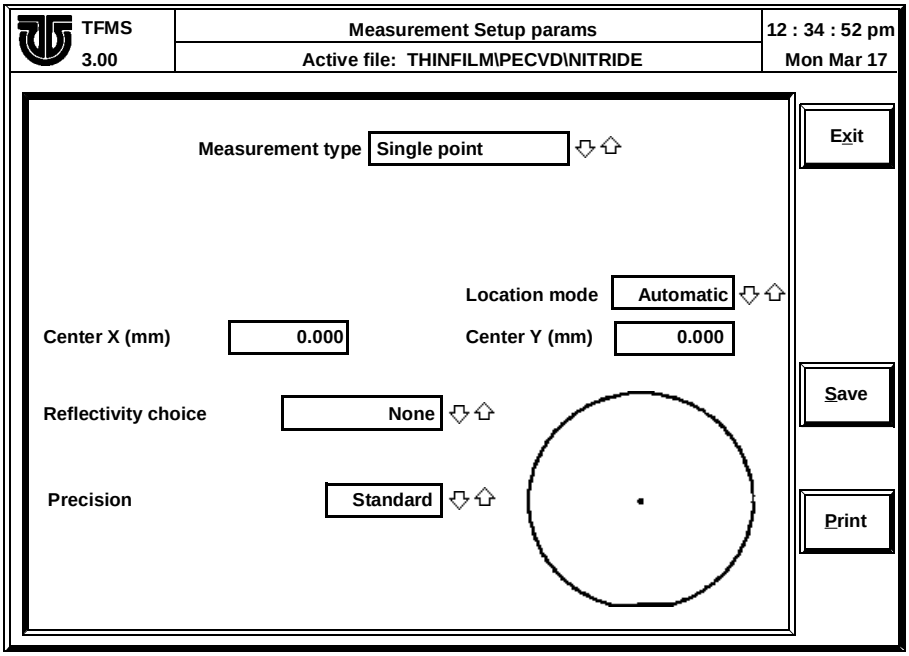
The resist coated wafer is exposed starting from the "zero" reference die in increments as small as 1 mjoule. The resist is then developed, and the Opti-Probe automatically measures and plots the film thickness at each exposure site versus the exposure energy. In addition, the system performs a linear fit between the 20% and 80% thickness points, and uses this fit to calculate the sensitivity, E_0, the contrast, γ_p, and E_i, the energy where the resist is first attacked by the developer. The system calculates the mean and standard deviation of the parameters and displays this information on the screen.

5.3 SETTING UP A UV REFLECTIVITY MEASUREMENT

5.3.1 Measurement setup

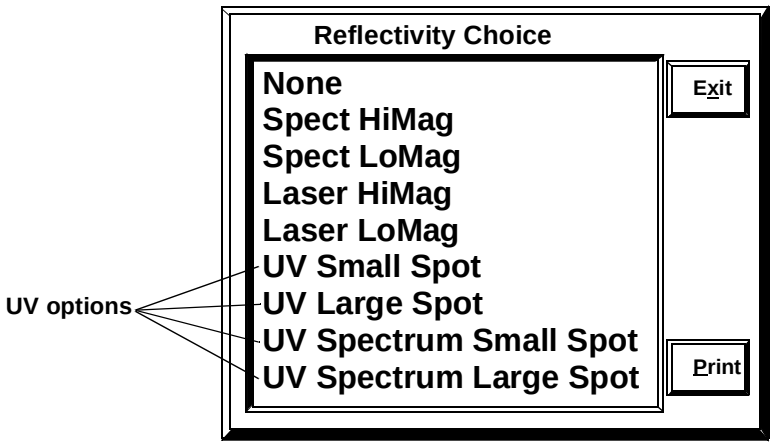
You configure a UV measurement in the Measurement setup parameters window (*Setup*/*Recipe*/*Measurement*) shown in Figure 5.5.

Figure 5.5 Measurement Setup parameters window



When you select the *Reflectivity choice* field, a pop-up menu appears where you select one of the UV reflectivity options shown in Figure 5.6.

Figure 5.6 Reflectivity choice pop-up menu



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UV Small Spot, UV Large Spot

Specify the measurement of normalized reflectivity at a single wavelength using either the small aperture (beam spot of 15µm) or the large aperture (beam spot of 40µm). You can select these reflectivity choices for all measurement types. Like non-UV reflectivity measurements, you enter a single wavelength in the *Wavelength* field. The default value is 2480Å. This value is a standard stepper wavelength used in production.

Precision :For UV Small Spot and UV Large Spot measurements, the Precision measurement options function as follows:

Standard:Specifies a UV system test for each wavelength every 60 minutes (this is the default entry).

High:Specifies a UV system test before *each* measurement.

Very High:Specifies that the system performs five separate reflectivity measurements at each measurement site, excludes the highest and lowest measurement results for each parameter measured, and averages the remaining three measurement results.

Custom:Uses the specified number of exclusions and number of measurements (*More* button, as in other measurement modes: visible reflectivity, measurement of t,n,k).

UV Spectrum Small Spot, UV Spectrum Large Spot

These *Setup*/*Recipe*/*Measurement*/*Reflectivity choice* parameters specify a reflectivity measurement at several different wavelengths using either the small aperture (beam spot of 15µm) or the large aperture (beam spot of 40µm). You can only select these reflectivity parameters for a single point measurement. When you select either of these options, the *Measurement type* field changes to *Single point* and cannot be changed (view-only) until you de-select a spectrum measurement. In addition, you see three additional UV parameters, *Start (A)*, *End (A)*, and *Number of Wavelengths*, and the *Precision* field does not appear, as shown in the example in Figure 5.7 with *UV Spectrum Large Spot* selected as the reflectivity choice.

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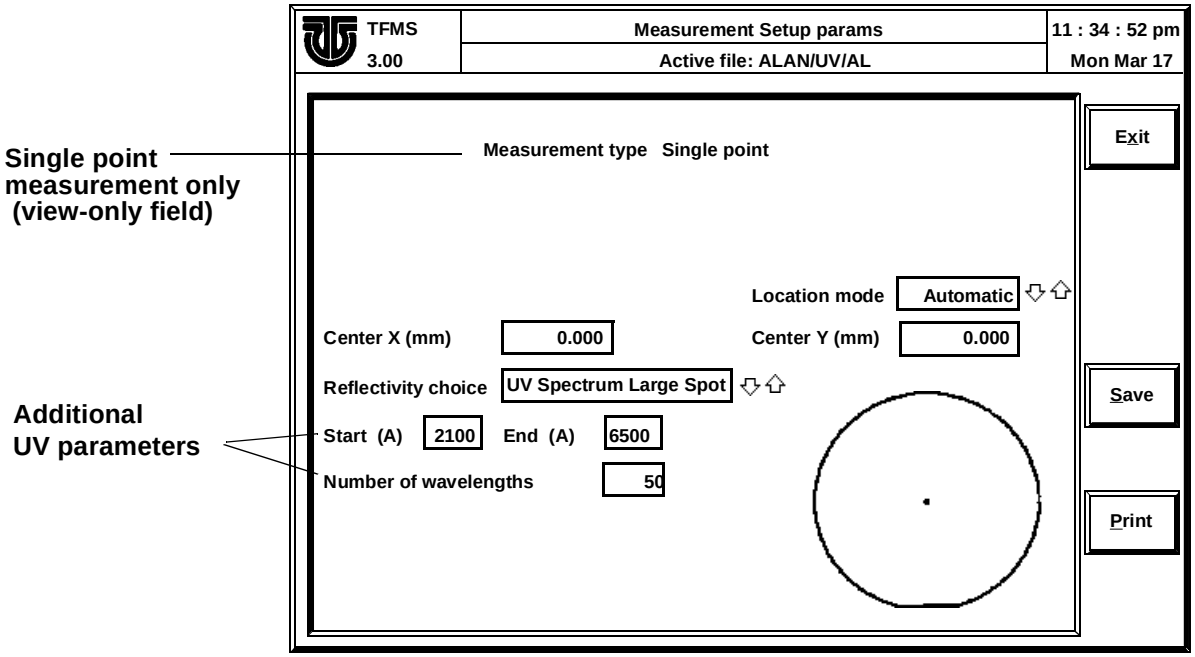
Figure 5.7 Measurement Setup parameters window (Reflectivity choice = UV Spectrum Large Spot)



Start (A), End (A): Specify the starting wavelength and the ending wavelength for the reflectivity measurement.

Number of wavelengths: Specifies the number of different monochrometer wavelengths at which the system measures reflectivity.

5.4 DISPLAY MENU

When you select *Main menu*/*Display*, two UV display options appear, *Overlay* and *Gamma Curve*, as shown in Figure 5.8.

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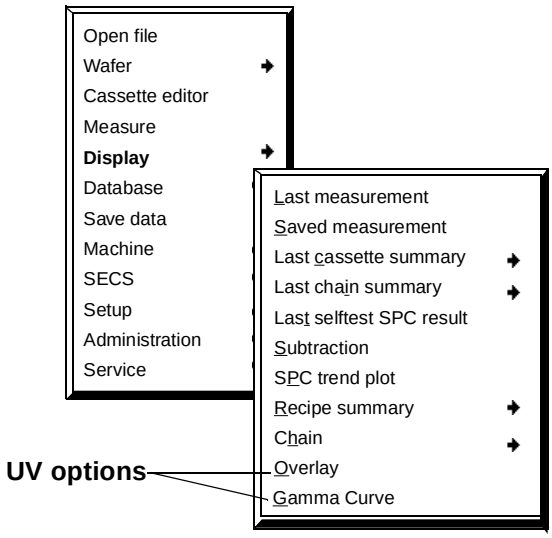
Figure 5.8 Display menu

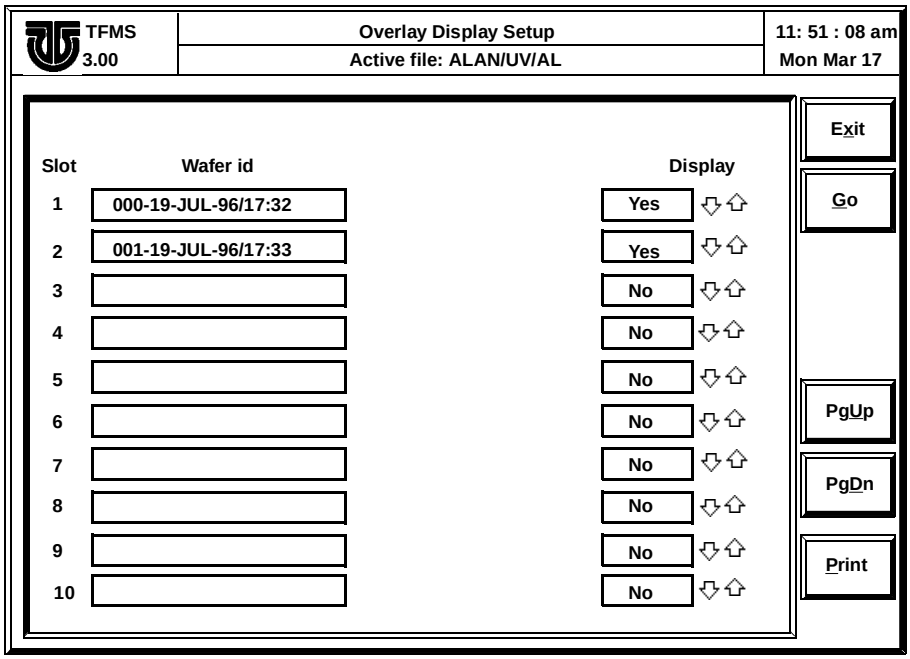


5.4.1 Display/Overlay

This UV display option allows you to compare the spectra of two or more UV spectrum measurements that used the same job file. This can be helpful for applications with anti-reflective coatings (ARC's) where you measure films of different thicknesses to compare reflectivity vs. wavelength profiles.

When you open a job file with saved measurements, and then select *Display*/*Overlay*, the Overlay Display Setup window appears. When you select the *Wafer id* field for a corresponding slot number, the Select overlay measurement window appears with a list of the active job file's measurement records. In this window, you can select a spectrum measurement record. After you select two or more spectrum measurement records, they appear in the corresponding fields in the Overlay Display Setup window, as shown in the example in Figure 5.9. You select *Yes* in the *Display* fields for each of the measurements you want to overlay in a plot display, and then select the *Go* button. A single graph appears in the Overlay Plot window, as shown in the example in Figure 5.10.

Figure 5.9 Overlay Display Setup window (after selecting two spectrum measurements)



Go button

When you select the *Go* button, a graph displays two or more overlaid plots corresponding to each of your selected measurements. You also see a *cycle* button in the window's right margin. When you select the *Cycle* button, you toggle between each of the displayed curves and display the corresponding reflectivity value (Y) above the graph. The active curve's data points appear in red and the corresponding saved measurement record is identified below the scroll bar.

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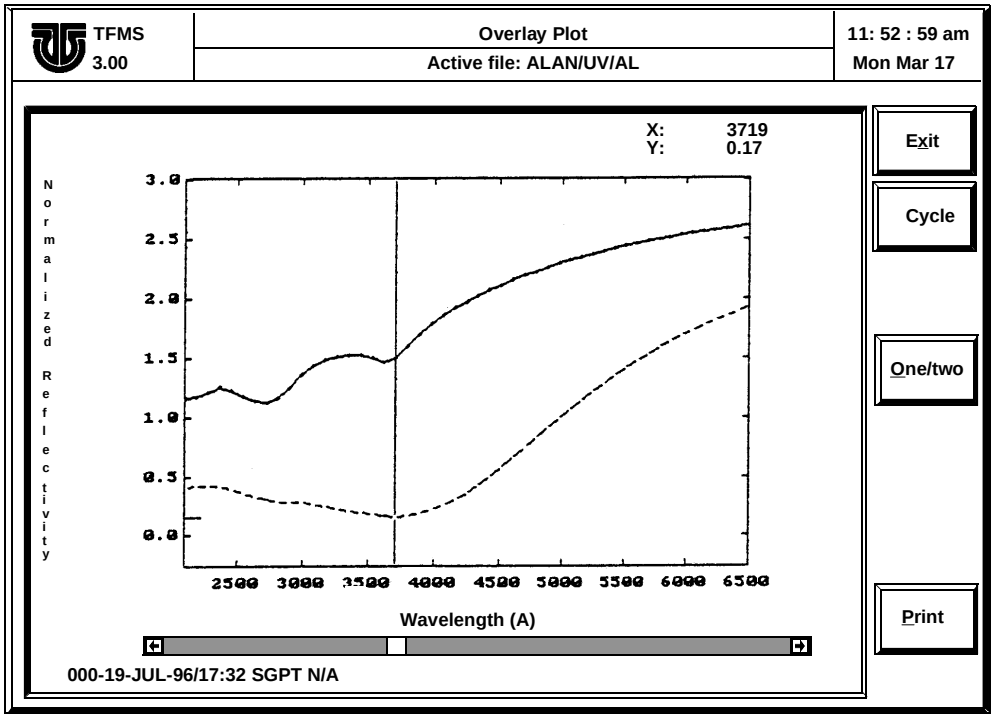
Figure 5.10 Overlay plot window

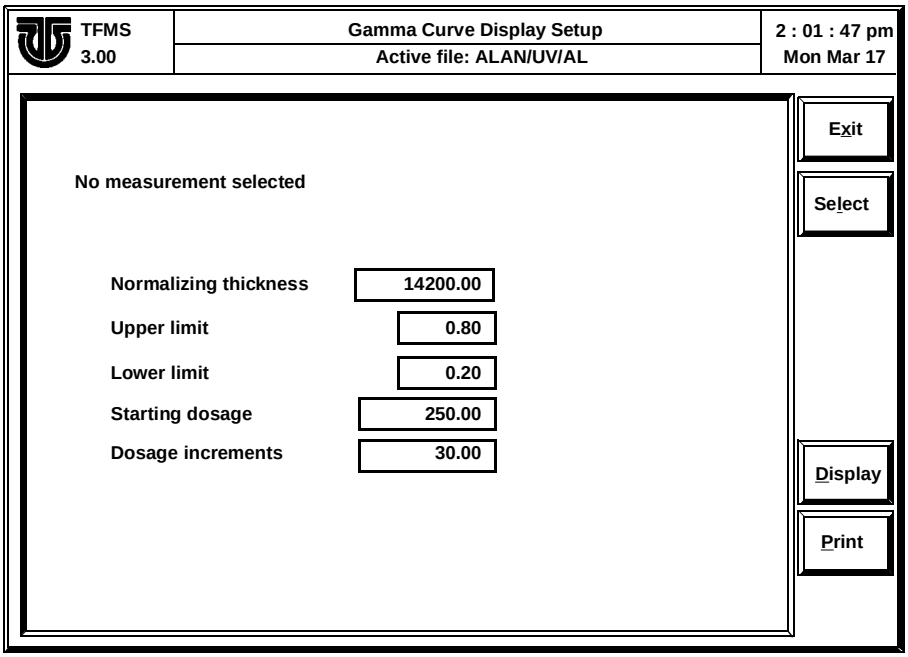


5.4.2 Display/Gamma Curve

This UV display option allows you to determine the characterization of UV resist samples, as described earlier in this section. A gamma curve is a plot of thickness vs. log(Dose), where the dose is the amount of energy absorbed by the resist. The slope of the line is a measure of the contrast of the resist, while the end-point of the line is an estimate of the sensitivity or dose to clear.

When you open a job file with saved measurements, and then select *Display/Gamma Curve*, the Gamma Curve Display Setup window appears, as shown in Figure 5.11. In this window, you enter values for Normalizing thickness, Upper limit, Lower limit, Starting dosage, and Dosage increments for the Gamma curve you want to display. When you select the *Select* button, the Select Gamma measurement window appears with a list of the active job file's measurement records. In this window, you can select the measurement record you want to use for your Gamma Curve. When you select the desired measurement record, it is indicated at the top of the Gamma Curve Display Setup window.

Figure 5.11 Gamma curve display setup window



Normalizing thickness: Specifies the thickness of the resist without any applied dose. In most cases it is the first point in a BPR thickness measurement (see Figure 5.2).

Upper limit, Lower limit: Specify the upper and lower fraction of the curve to define the linear region that the system fits. For example, a lower/upper limit of 0.20/0.80 means that the lower and upper 20% of the data in the linear region is excluded from the fit.

Starting dosage: Specifies the initial dose (typically in units of mJ/cm^2).

Dosage increments: Specifies the additional dose that each successive site receives.

Display/Gamma Curve/Display: When you select the *Display* button after configuring the above parameters, a gamma curve appears, showing the normalized thickness vs. log(dose). This plot looks similar to the example in Figure 5.1 shown earlier in this section. It displays a flat region (where the dose is too small to cause any clearing), followed by a linear region, which is also followed by a flat region (where the resist is completely cleared).

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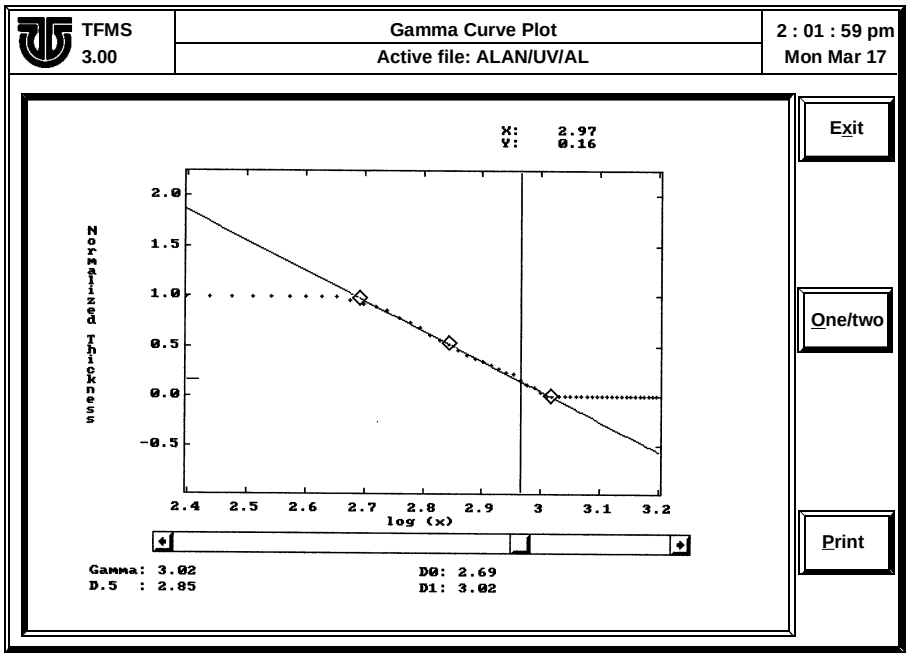
On the Opti-Probe, you should also see three diamonds on the best-fit line corresponding to D(0), D(0.5), and D(1), as shown in the example in Figure 5.12. Each of these refers to the log(dose); where clearing begins, (D0), where resist is half-cleared, (D.5), and where it is completely cleared (D1).

You should note the D(0), D(0.5), and D(1) values that appear on the screen and confirm the validity of these results by calculating the actual dose and comparing this to the starting dose and dose increment originally provided to you.

Figure 5.12 Gamma Curve plot window



5.5 PERFORMING AND DISPLAYING UV MEASUREMENTS

For a job file set up to measure UV reflectivity, you perform a manual measurement using a single wafer. The Opti-Probe records the incident and reflected signals from the detectors and measures the reflectivity of the reference at the specified wavelength(s).

The measurement results show a value for the reflectivity of the sample normalized to the reflectivity of the reference Si sample. This information is displayed in a measurement results window, as in any other type of measurement (*Display*/*Saved measurement* or *Last measurement*). Following are some examples of UV reflectivity measurement results:

Figure 5.13 UV large spot (line scan)

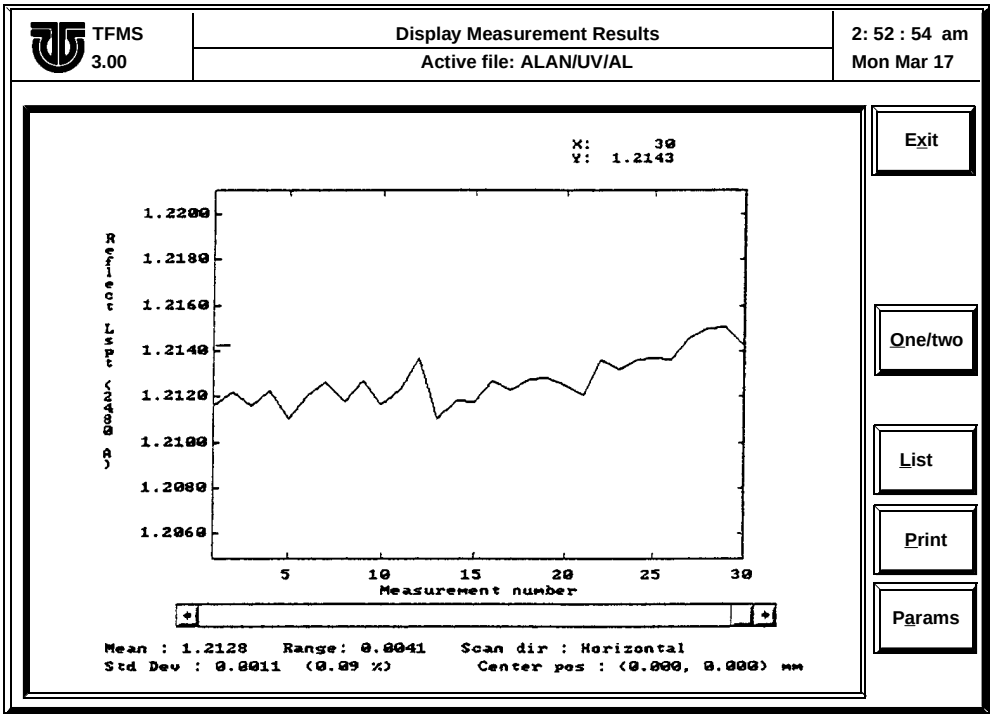


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Figure 5.14 UV large spot (Single point measurement - No *Show* button for UV results)

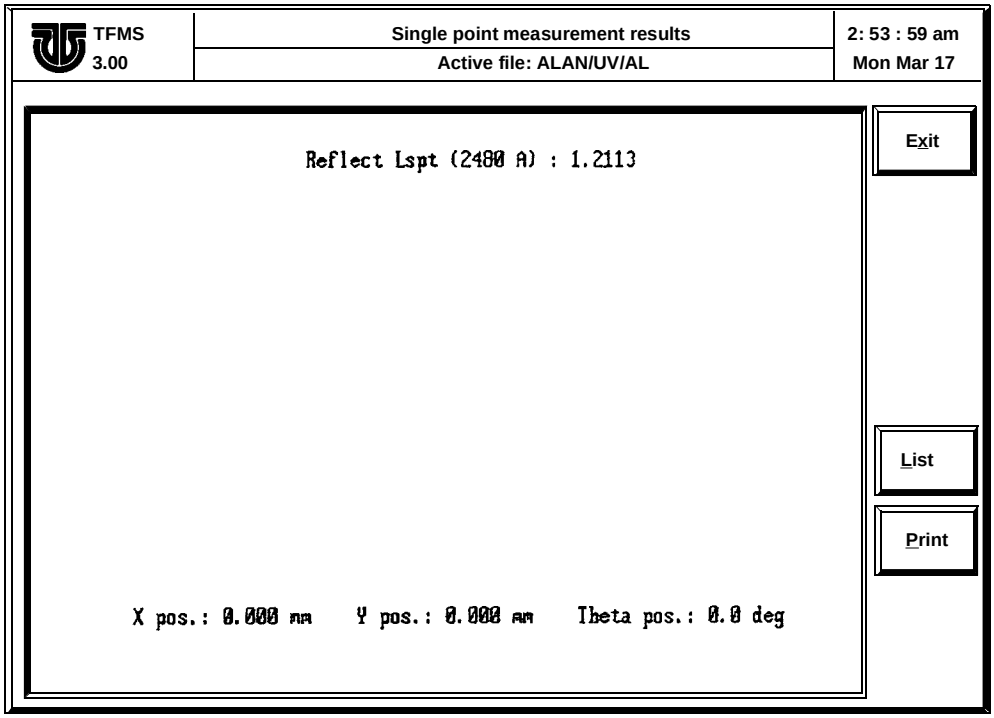

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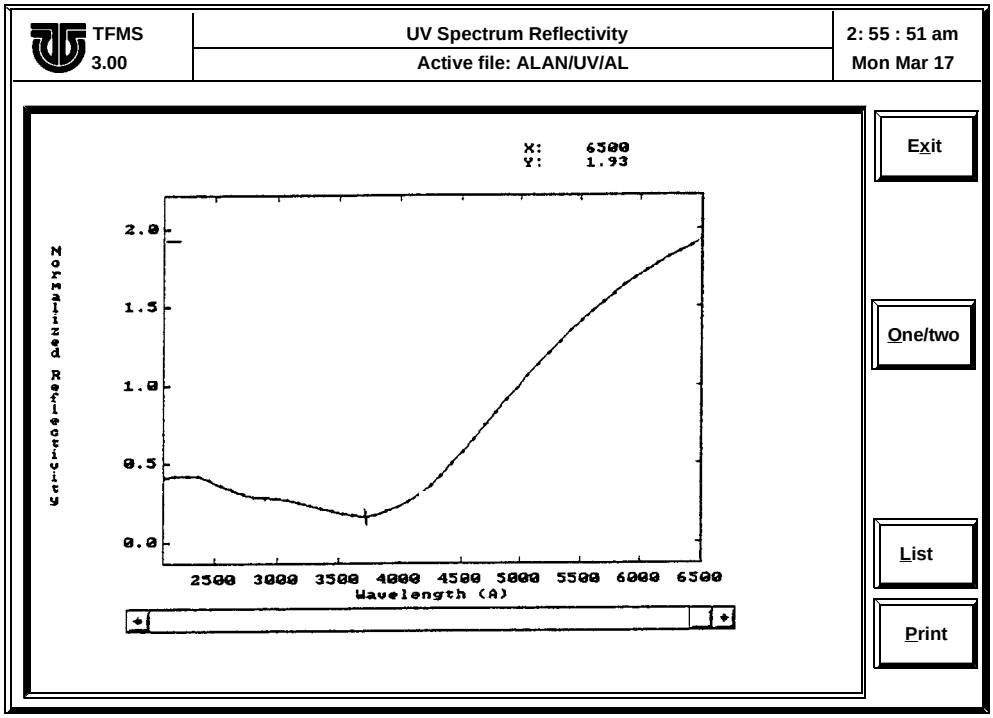
Figure 5.15 UV spectrum large spot (Single point measurement - No Show button for UV results)



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6

SYSTEM EXPERT FUNCTIONS

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In this section, you'll learn about the Opti-Probe's System Expert functions. To access these functions, you must have a System Expert or System Managerlevel User ID. To effectively use the System Expert functions, you'll need tounderstand more about film properties and processing than you do at the Engineer level.

Before you begin this section, you should know how to setup and operate the system at the Engineer level, as described in Section 3, "Engineer Functions."

When you log into the system with a System Expert level User ID, the Main Menu window reappears with a different color border that identifies the System Expert level. Other than the color, the Main Menu window looks the same as it does at the Engineer level.

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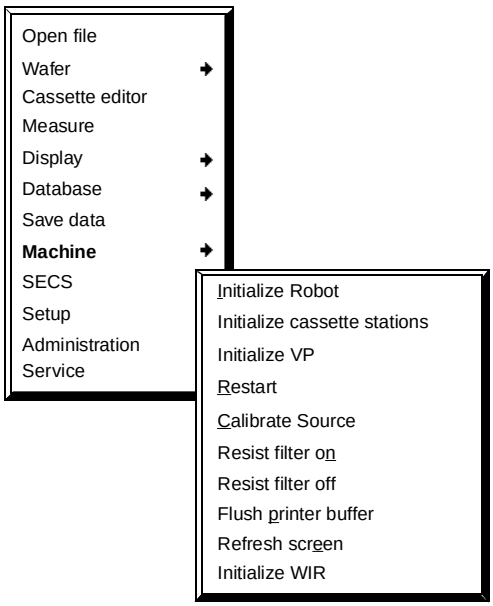
6.1 MACHINE MENU

When you select *Machine* in the Main menu, the Machine menu appears, as shown in Figure 6.1. With your System Expert level User ID, you can access two additional options in the Machine menu: *Resist filter on* and *Resist filter off*, as shown in Figure 6.1.

Figure 6.1 Machine menu (System Expert level)



6.1.1 Resist filter on, Resist filter off

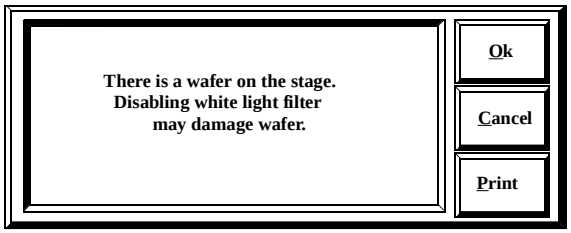
When you select *Resist filter on* or *Resist filter off* in the Machine menu, the yellow filter, located in the white light path, is inserted (on) or removed (off). The white light allows you (and the VP, if installed) to see the pattern on a patterned wafer. You use the yellow filter to view samples with unexposed photoresist because it blocks the high frequency (short wavelength) components of the white light that would otherwise expose the resist. This filter blocks all wavelengths below 460 nm.

Each time you restart the system, the filter is reset to the default state, which is set up by the System Manager. You can use *Resist filter on* or *Resist filter off* to temporarily change the default state setting or verify the operation of the yellow filter. If your system is installed in a yellow room where the yellow filter may be

needed and the default state is set to the on position, the system automatically turns the filter on during a TFMS initialization.

You must load a wafer before you can visually verify the operation of the yellow filter. As the filter is inserted and removed, the color on the sample viewing monitor changes. When you select *Resist filter off* with a wafer on the measurement stage, a dialog box appears with a message, as shown in Figure 6.2, reminding you that the wafer can be damaged if unexposed photoresist is present.

Figure 6.2 Filter off dialog box



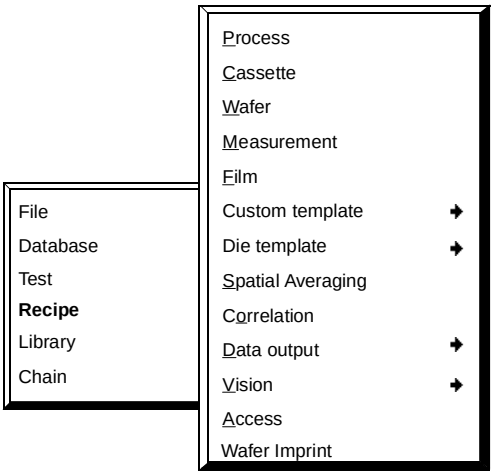
Select *Cancel* to cancel the operation and leave the filter in place. Select *Ok* to remove the filter.

Make sure you leave the system in its normal configuration when you're finished with your test.

6.2 RECIPE MENU

When you select *Setup*/*Recipe* , the Recipe menu (see Figure 6.3) looks the same as it does at the Engineer level.

Figure 6.3 Recipe menu (System Expert level)



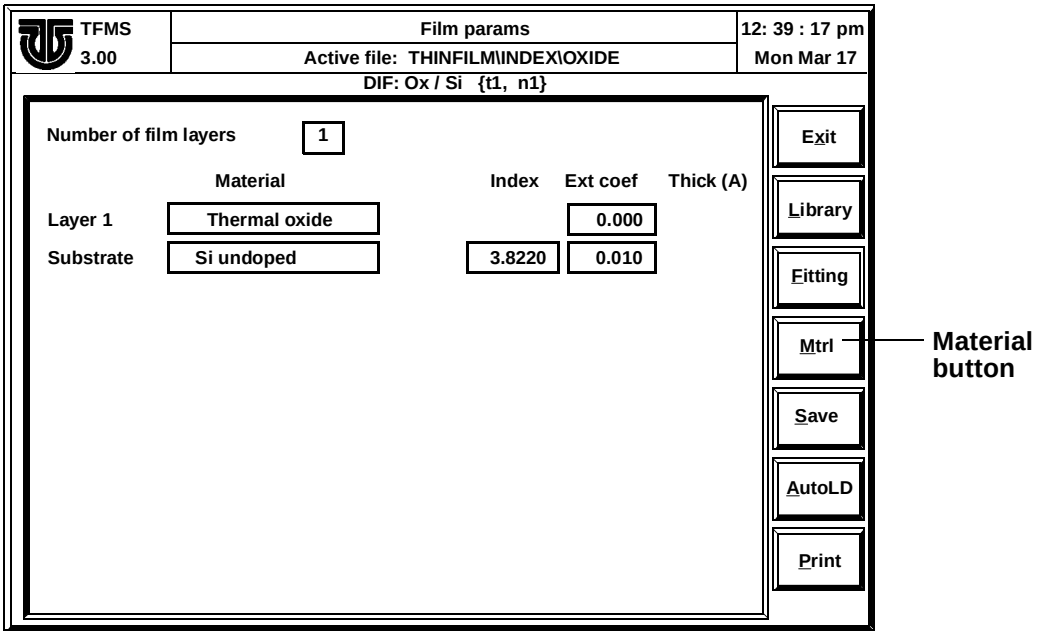
6.2.1 Film

When you select *Setup*/*Recipe*/*Film*, the Film parameters window appears, as shown in the example in Figure 6.4. In this window, you can select a film stack from the Film Library and modify the parameters, if required. You can also define the Film stack parameters (known parameters), which are fixed during the measurement, and select the parameters to be measured. At the System Expert level the *Fitting* button, described in Section 3 for the Engineer level, also provides access to the advanced calculation, scattering, and fitting parameters. You can save all these parameters along with the rest of your film setup by selecting the *Save* button in the Film parameters window.

The initial release of TFMS 3.00 may not include the *Mtrl* button, shown in Figure 6.4. This button allows you to characterize the film and substrate (set up a dispersion model), and perform other advanced functions, described later in this section. Future TFMS 3.00 upgrades will include the *Mtrl* button and its associated features.

If your job file is set up for a reflectivity measurement, the *Fitting* and *Mtrl* buttons and the *Index*, *Ext coef* , and *Thick (A)* parameters are not applicable, and do not appear in the window.

Figure 6.4 Film parameters window (System Expert level)



At the System Expert level, you can perform functions in the Film parameters window that are not accessible at the Engineer level. Once you select a film stack using the *Library* button, you can still change all the setup parameters. In addition, you can create a recipe for a film stack that is not included in the film selection library. If you experience any difficulties setting up a recipe for your film stack, contact Therma-Wave Applications Staff for assistance.

Whenever you set up a recipe, you should start with an existing job file that is similar to the one you'd like to create. The most important similarities are in the film stack and template pattern (if used). This approach saves you time and effort by eliminating the need to re-configure the parameters in the new job file that have the same entries as those in the original one. Therma-Wave provides a generic setup in the job file SETUP\GENERIC\JOBFILE, as well as a library of standard film stacks and measurement parameters. See *Library* button, later in this section.

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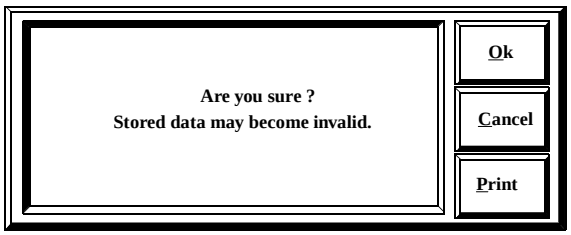
Number of film layers

Specifies the number of film layers in your sample. The system is set up to measure a maximum of four film layers. Upon request, Therma-Wave can set up the system to measure up to seven film layers. When you select this field, a calculator window appears where you enter the desired number. In general, avoid changing the number of film layers. Instead, start with a standard film stack or existing job file containing the desired number of film layers. Some internal calculation parameters (See Calc params, later in this section) and database storage parameters depend on the number of film layers. If you change the number of film layers, a dialog box appears, as shown in Figure 6.5.

Make sure there are no saved measurements before changing the number of film layers.

Figure 6.5 Number of film layers dialog box



Material - Layer(s), Substrate

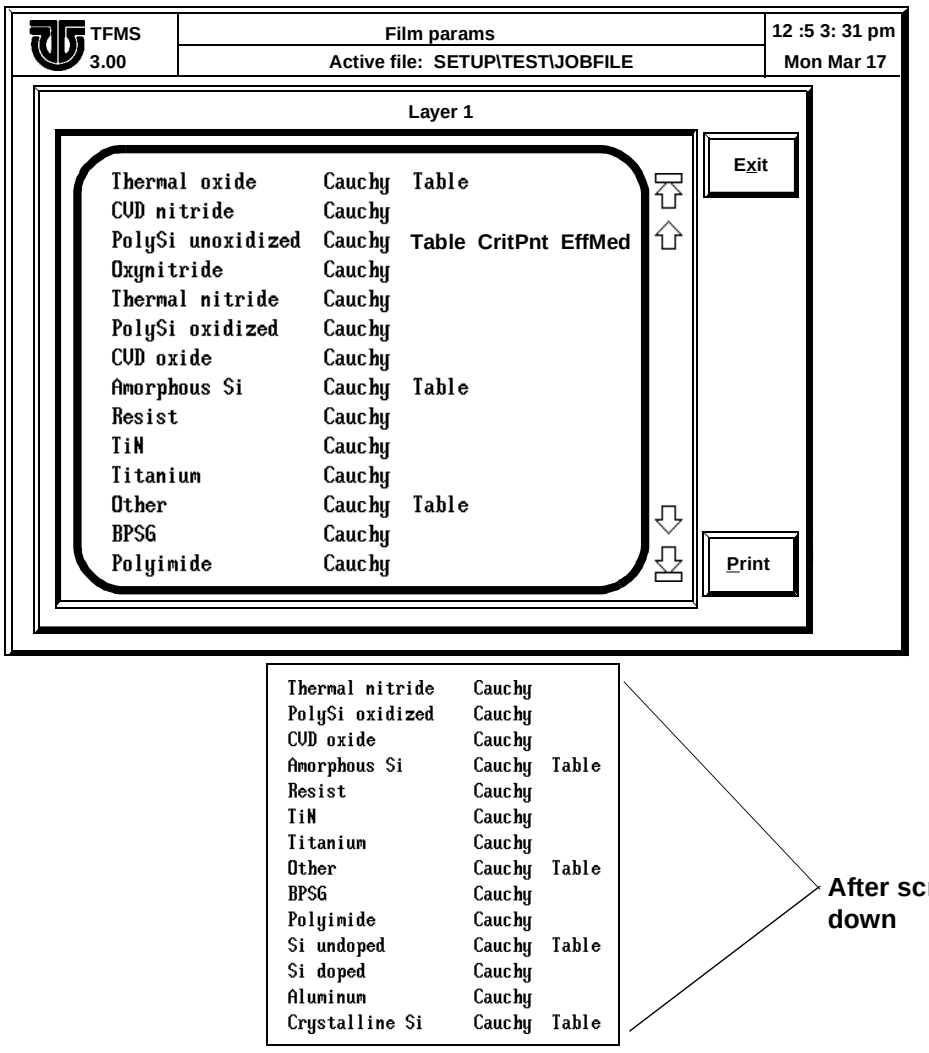
Specify the films in the stack as well as the substrate. For most applications, you should find the desired film stack in the Film Setup Library, which you can access using the *Library* button, described later in this section. If not, you can manually create the required film stack by selecting individual film layers and the substrate from Therma-Wave's film and substrate libraries. When you select the film or substrate material fields, the corresponding window appears with a list of all of the TWI-defined materials, as shown in Figure 6.6. Any user-defined materials (described in detail later in this section) appear at the end of the list.

You select the desired materials from the lists. The optical constant values used for the materials in the libraries are based on Therma-Wave's extensive experience. Each library contains a list of standard materials, along with the option *Other*. You can change the optical constants of *Other* to correspond to any material that may not appear in the library, and enter a different value for *Other* in each of your job

files. Therma-Wave periodically updates and expands the film and substrate libraries. If you have special requirements, contact Therma-Wave Applications Staff.

The *Cauchy*, *Table*, *Crit Pnt*, and *Eff Med* entries, shown in the example in Figure 6.6 may not be applicable for the initial TFMS 3.00 release. These entries indicate that the corresponding film or substrate also includes a Cauchy coefficients, lookup table, critical point, and/or effective medium material characterization setup. The first TFMS 3.00 upgrade that provides this feature will only include default characterizations for *Cauchy* and *Table* , and not *CritPnt* or *EffMed*. Each of the material characterization types is described in detail later in this user guide.

Figure 6.6 Film/Substrate library pop-up menu



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Film stack params - Index, Ext coef, Thick (A)

The optical constants (index of refraction, extinction coefficient) and thicknesses shown in the Film parameters window are fixed during the measurement. When you select a film stack, the system obtains the default optical constants from the film and substrate libraries. These values correspond to the laser wavelength (6730-6790 Å) and are appropriate for most applications.

You must enter correct film parameter values that are fixed (i.e., not measured) for your job file.

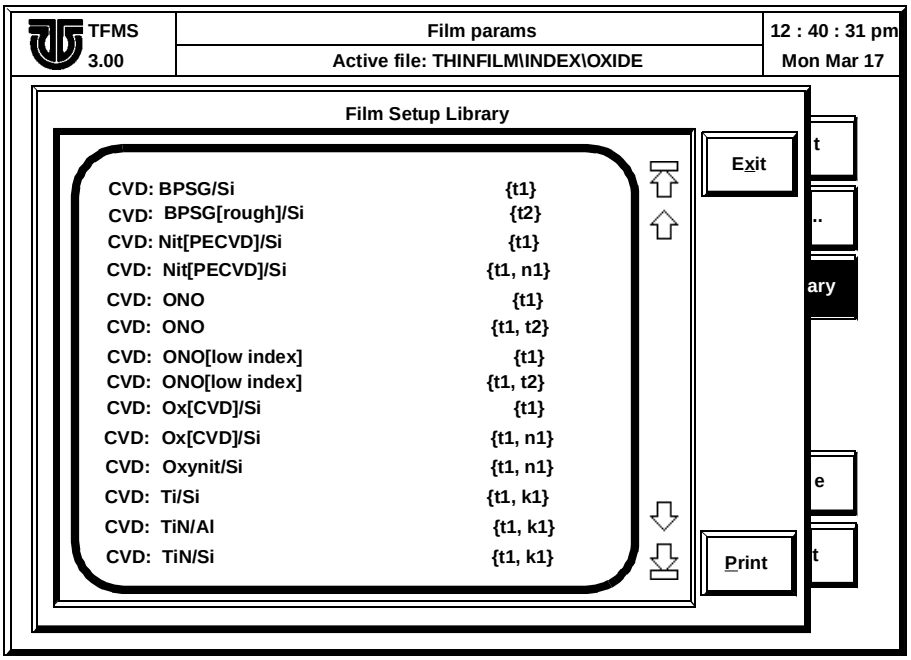
You edit a value by selecting the corresponding field. A calculator window appears where you enter the desired value. The System Manager can configure the system to display all thicknesses in either angstroms or nanometers.

Library button

When you select the *Library* button in the Film parameters window, the Film Setup Library window appears, as shown in Figure 6.7. This window contains a list of TWI defined standard film stacks and measurement parameters, displayed by process type and film type in alphabetical order. You can define a new film stack by changing parameters in a standard film stack and saving those changes. At the end of the standard film stack list, if any user-defined film recipes are saved, they appear in alphabetical order with default names (by film name, parameters to be measured, date, and time) or personal names. You can enter a personal name for a user-defined film stack in the Film Library Maintenance window, described in Section 3, "Engineer Functions." The scrolling arrows at the right side of the window work like those in the Open window. See "Scrollable list windows" in your "Getting Started" manual.

A complete list of all the standard film stacks in the Film Library appears in Appendix B.

Figure 6.7 Film Setup Library window



Each entry in the Film Setup Library window includes an abbreviated description of the film stack. In some cases this includes restrictions on one of the film thicknesses. For example, there are separate calculation recipes for Poly/Ox/Si and Poly/ThinOx/Si. In addition, each entry displays the parameters to be measured in curly brackets, e.g.,{t1, n1} is the thickness and index of refraction of the top film.

You select a film stack the same way you select an entry in any other list. When you select a film stack, the Film parameters window reappears with all of the appropriate entries in their respective fields. The name of the film stack and the parameters to be measured appear in the Status line, as shown in Figure 6.8. In addition, the system automatically enters the appropriate parameters in the Fit parameters window, Spatial averaging parameters window, Advanced film setup window, and Advanced Calculations parameters window. These parameters are part of the film recipe because they can vary among film stacks. If you change any of the default parameters, the film stack setup is no longer a standard configuration and its name changes to User-defined film setup.

Save button

The *Save* button in the Film parameters window performs some additional functions. In this window, when you select a film stack using the *Library* button,

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the system automatically enters parameters in several other windows, as described above. When you select the *Save* button, the parameters in the same windows are saved to the hard disk, if you have change privileges for the active job file.

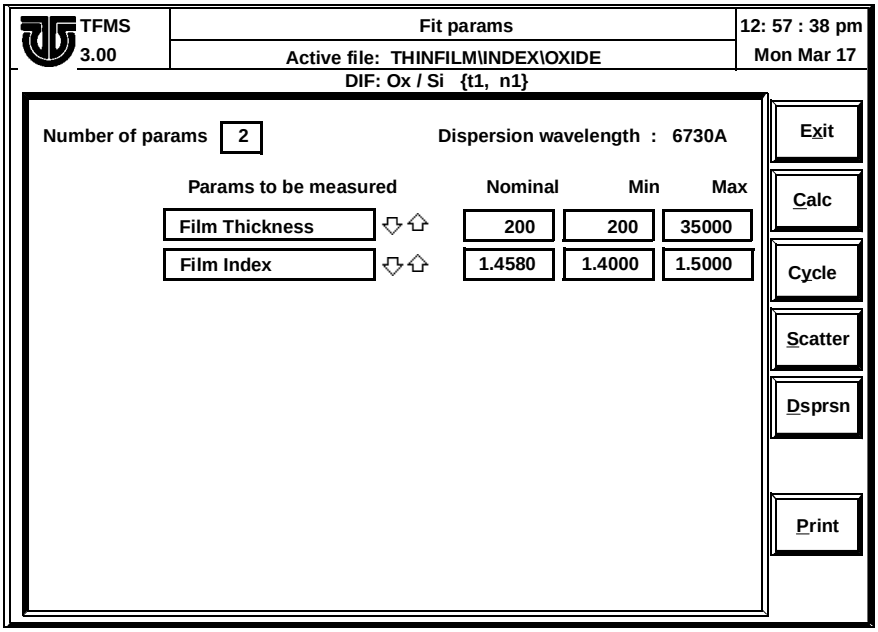
Saving a user defined film: If you select the *Save* button after changing a standard film stack's parameters, a confirmation dialog box appears asking if you want to save your changes. If you confirm your changes, a Status line message says: *Searching for matching Film Library entry.* If an identical film setup is already saved in the library, the system opens that film setup and displays its name in the Status line. If the same configuration is not saved, another Status line message says*: Creating new Film Library entry,* and then its default name appears in the Status line (by film name, parameters to be measured, date, and time). This new entry appears in the Film Library in alphabetical order with any other user-defined films, following the list of TWI standard film stacks. Currently, if you only change spatial averaging parameters, the system does not create a new entry. You can modify a default film entry and enter a personal name by using the *Edit* function in the Film Library Maintenance window (*Setup*/*Library*/*Film*), described in Section 3, "Engineer Functions." After you save your new film setup, its name appears in the Status line each time you open the job file's Film parameters window.

Fitting button

At the System Expert level, when you select the *Setup*/*Recipe*/*Film* /*Fitting* button, the Fit parameters window appears. In this window, you can set up the measurement parameters and configure some additional functions using the *Calc*, *Cycle*, *Scatter*, and *Dsprsn* buttons, shown in Figure 6.8.

The initial release of TFMS 3.00 may not include a *Dsprsn*(Dispersion) button or any of the dispersion parameters, described later in this section. Future TFMS 3.00 upgrades will include the *Dsprsn* button and its associated features.

Figure 6.8 Fit parameters window (System Expert level)



Number of params: Specifies the number of parameters to be measured. The system is set up to measure a maximum of four parameters. Upon request, Therma-Wave can set up the system to measure up to six parameters. Some film stacks have entries in the Film Library list for more than one combination of measurement parameters, for example a one and a two-parameter recipe. For most applications, you won't have to edit the number of parameters if you choose your film selection carefully.

After you save data in a job file's database, do not change the number of parameters to be measured or their identities. Some internal database storage parameters depend on the number and identity of measured parameters. If you change them, your old data cannot be identified correctly, and no warning message appears.

Params to be measured: Specify the parameter(s) to be measured (located at the lower left side of the window).
You can select from the following options:

- Thickness of any of the films
- Film index of refraction or extinction coefficient (any film)

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- Substrate index of refraction or extinction coefficient

Therma-Wave only recommends specific parameter combinations. The Film Library includes the most common and recommended combinations. You should not have to change the params to be measured entries for most applications. When you select any of these fields, a pop-up menu appears with a list of measurement parameters. The list of options changes with the number of film layers, as shown in Figures 6.9, 6.10, 6.11 and 6.12. You select the desired measurement parameter, and it appears in the corresponding field in the Fit parameters window. Usually, the top film thickness (Layer 1) is the first measurement parameter (Param 1).

Figure 6.9 Params to be measured pop-up menu (single-layer film)

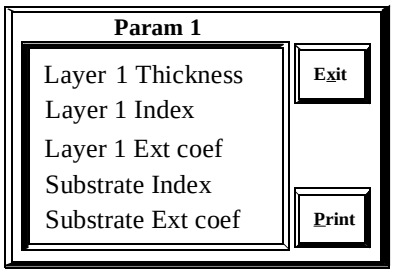


Figure 6.10 Params to be measured pop-up menu (two-layer film)

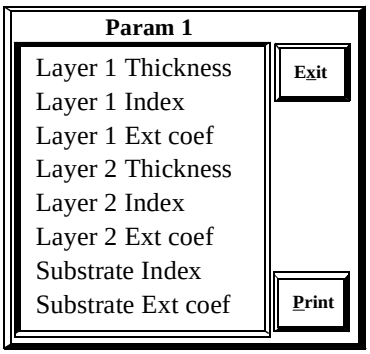


Figure 6.11 Params to be measured pop-up menu (three-layer film)

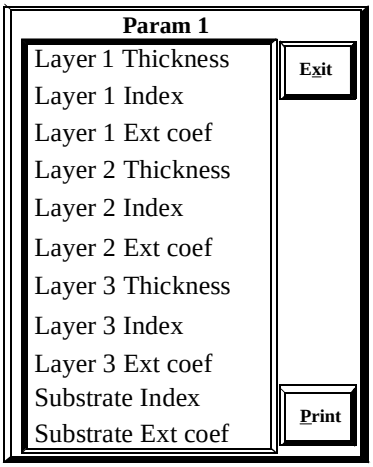
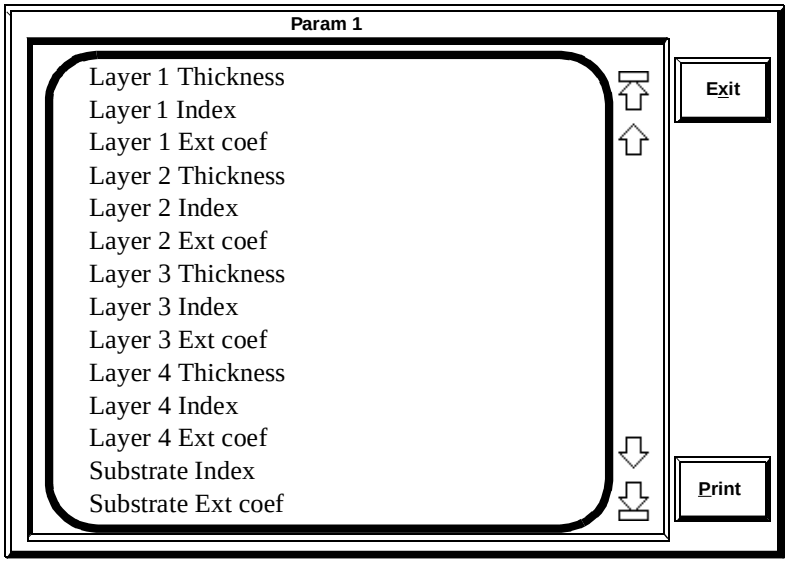


Figure 6.12 Params to be measured window (four-layer film)



Nominal, Min, Max: Specify a nominal value and a range for each measured parameter. In most situations, the default nominal, minimum, and maximum values are adequate. It is not necessary to enter a nominal value for the thickness of

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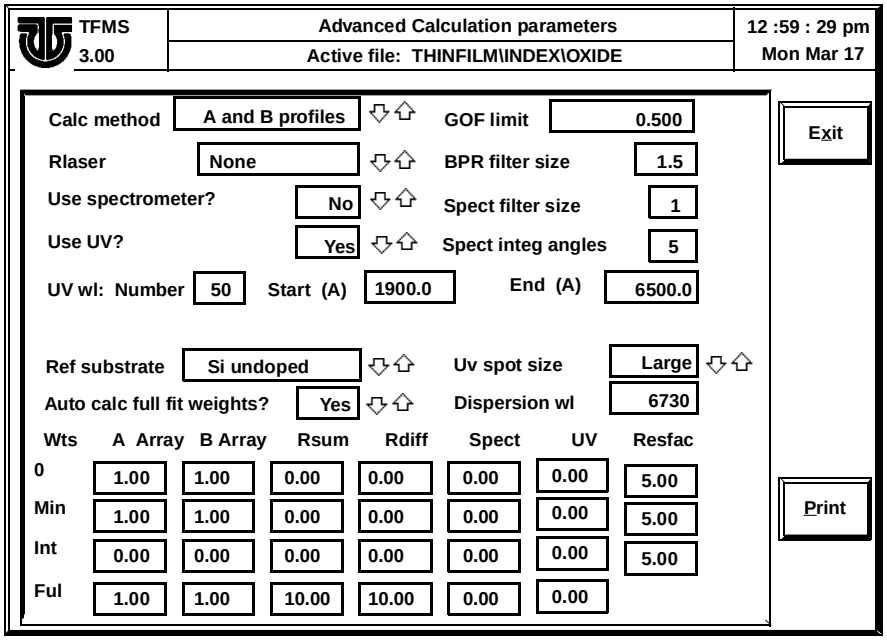
a single film or for the top layer of a stack. You should enter correct nominal values for the parameters to be measured for the bottom layers in multi-layer films.

The measurement result always falls between the minimum and maximum values. Occasionally, the measured data and the film setup may be so inconsistent that the fitting routine cannot find a good fit within the specified range(s). When this happens, the residual and goodness of fit have bad values, as described in Section 2, "Operation Summary." Make sure you selected the correct film stack and specified the appropriate ranges. If you're still having trouble with your measurement, contact Therma-Wave Applications staff for assistance.

Calc button

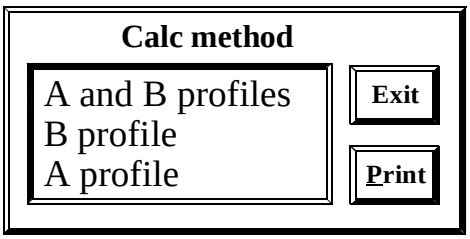
When you select the *Setup*/*Recipe*/*Film*/*Fitting*/*Calc* button, the Advanced Calculation parameters window appears, as shown in the example in Figure 6.13 with a UV measurement enabled (on a DUV system). The UV parameters do not appear on systems that do not have DUV hardware installed (except for the UV weights parameter). In general, settings in this window depend on the film stack selected in the Film parameters window. Exercise caution before editing any values in this window. For more information, contact Therma-Wave Applications Staff or attend the advanced applications course.

Figure 6.13 Advanced Calculation parameters window



Calc method: Specifies which array(s) to use in the Beam Profile Reflectometry (BPR) measurement. The A array measures s polarized reflected light (A profile), while the B array measures p polarized reflected light (B profile). When you select this field, a pop-up menu appears, as shown in Figure 6.14.

Figure 6.14 Calc method pop-up menu



GOF limit: Specifies a lower limit for a satisfactory goodness of fit (GOF). Measurements with a goodness of fit greater than this value are counted as "good" in the Run Summary window. The default value, 0.5, is typically too low to have any effect.

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The goodness of fit is a measure of the confidence the system has in the measurement result. The value can range from 0 (no confidence) to 1 (perfect fit and complete confidence) and is based on the measurement residual and the film thickness. Specifically,

GOF = 1.0 - 10 x normalized_residual

where:

normalized_residual = residual / (1 + 2 x ncycles)

ncycles = the number of peaks and valleys in the A profile, which increases with thickness.

For example, if you're measuring a 1000 Å oxide film (<1 cycle) with a residual of 0.001 the GOF is 0.99, which is an excellent value. For a measurement on a similar film with a residual of 0.01 the GOF is 0.90. When comparing similar films, then, a GOF value of 0.90 is really ten times worse than a GOF of 0.99. This formulation largely removes the normal increase in residual with thickness. However, it does not fully accommodate the fact that different films may typically have different residuals for the same thickness.

The GOF appears in Measurement results windows and is included in all Wafer measurement reports, so it is fairly easy to determine typical values for a given wafer processing step and job file. If you need help determining an appropriate value to enter in this field, contact Therma-Wave Applications Staff.

Rlaser: Specifies whether to use the total integrated intensity (Rsum signal) in a film measurement. For systems with an ellipsometer installed, this parameter also specifies whether or not to use the ellipsometer (Rdiff) signal. When you select this field, a pop-up menu appears, as shown in Figures 6.15 and 6.16. When you select a film stack, the default value entries are appropriate; for more information, contact Therma-Wave Applications Staff or attend the advanced applications course.

Figure 6.15 Rlaser pop-up menu (Systems without an ellipsometer)

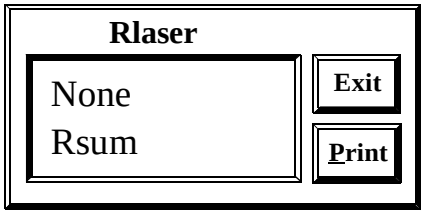

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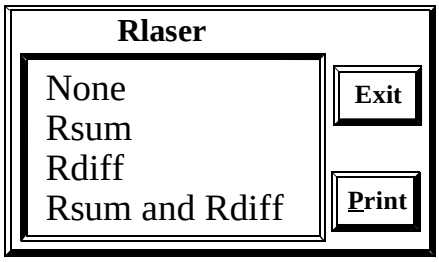
Figure 6.16 Rlaser pop-up menu (Systems with an ellipsometer)



BPR Filter size: The BPR filter is a constant angle filter. The BPR filter size determines how much smoothing/filtering the system applies to the measured profiles before fitting the calculated parameters. In this field, a System Expert or System Manager level user can enter the filter's half width. The default entry is 1.5°, indicating that each profile data point is an average that includes that data point and all other data points within ±1.5° (3 pixels). The data for the A and B arrays span a range of approximately 0-60°. For very thick dielectrics (e.g., >80,000 Å) that have high frequency information (numerous oscillations) in their profiles, decreasing the filter size to 0.5° - 1° can provide a better fit. If the filter width is comparable to about a quarter of a profile cycle, the filtering begins to remove reflectivity information.

Spect filter size : Modifies the array spectrometer filter size to smooth the measured spectrum before the fitting calculations. The default entry is one pixel. The system uses approximately 150 pixels to represent the 4700-8000Å range, i.e., 22Å per pixel.

The system does not filter the wheel spectrometer data.

Spect integ angles: Specifies the number of terms (corresponding to angle values) used in the calculation for spectrometer measurements. The default value varies, depending primarily on the film stack. You should enter a value of 3 for high index films (e.g., polysilicon) or 5 for low index films (e.g., oxide).

Use spectrometer? Specifies whether or not to perform a spectrometer measurement. When you select a film stack using the *Library button* in the Film parameters window, the system automatically enters Therma-Wave's recommended selection in this field. In the visible wavelength range, the system

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performs measurements in the full available range, typically from 4700Å to 8700Å, with emphasis in the 5500Å to 8000Å range.

Use UV (DUV systems only): Specifies whether to perform a UV measurement with the respective job file. You can select the range used for a UV measurement. When the system is not performing a UV measurement, a shutter blocks the UV beam. For UV measurements, the system uses a different optical path and lens.

Start (A) / End (A) [DUV systems only]: Specify the starting wavelength and the ending wavelength for the reflectivity measurement.

UV wl (DUV systems only): Specifies the number of wavelength values sampled by the system within the above range. The system scans the range with a monochrometer, and obtains data at the selected number of wavelengths.

UV spot size (DUV systems only): Specifies whether to use the large aperture (40µm) or the small aperture (15µm) to perform a UV measurement.

Ref substrate: Specifies the representation for the reference chip. You can select from two options,

> ***Si Undoped (Cauchy) or Crystalline Si (Lookup Table).*** You should use Crystalline Si for all UV measurements. If your job file was created with a previous version of TFMS (before 3.00), you should use Si Undoped for non-UV measurements for backward compatibility. If your job file was created with TFMS 3.00, you can use either Si Undoped or Crystalline Si for non-UV measurements, (Crystalline Si is recommended). If you are not sure which Ref substrate to use, refer to the substrate in your job file's film stack.

Dispersion wl: Specifies the wavelength at which the system reports the calculated N & K values.

Auto calc full fit weights? Specifies whether the system adjusts the full fit weights according to the thickness obtained in the previous calculation steps, e.g., weights = 0 for A array and B array on very thin films and weights = 0 for Rsum and Rdiff on thick films. You can only specify this adjustment for thickness measurements and for single dielectric film on silicon e.g., DIF: Ox/Si {t1}.

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Currently, when you select *Yes* in the *Automatically calculate full fit weights* field for CVD: Ox/Si {t1} or CVD: Nit/Si {t1}, you must also select *Rsum and Rdiff* in the *Rlaser* field. This adjustment merges thin and thick film recipes on ellipsometer systems.

Wts: Specify the relative weights to be applied to the various signals (A array, B array, Rsum, Rdiff, spectrometer, UV, Resfac) for different stages of the calculation (zero iteration, minimal fit, intermediate fit, full fit). A signal must be enabled in the top portion of the window and have a non-zero weight in order to be used in the calculation. For more information about these parameters, contact Therma-Wave Applications Staff. When you select a library film stack, the default value entries are appropriate; for more information, contact Therma-Wave Applications Staff or attend the advanced applications course.

Resfac: Determine which candidate solutions pass to the next stage of the calculation. Candidate solutions are sorted by their residuals; then the residual factor is applied to eliminate candidates that are definitely incorrect. For example, if Resfac=5 for one stage in the calculation, the system eliminates all candidate solutions with residuals larger than 5+1=6 times the best (smallest) residual found. When you select a film stack, the default value entries are appropriate; for more information, contact Therma-Wave Applications Staff or attend the advanced applications course.

Cycle button

When you select the *Setup*/*Recipe*/*Film*/*Fitting*/*Cycle* button, the Advanced film setup window appears, as shown in the example in Figure 6.17. In this window, you can specify how the fitting routine varies the measurement parameter(s) between the minimum and maximum values to find the correct value(s). If the only measured parameter is the (top) film thickness, this window only displays the cycle selection layer. Figure 6.17 shows an example of this window when DIF: Ox [< 1000 A] /Poly/Ox /Si {t1, t2} is selected in the Film Library. You can select one film layer for cycle selection calculation and vary each of the other parameters 1-99 times, limited only by the available memory. If there is not enough memory available, the appropriate message appears.

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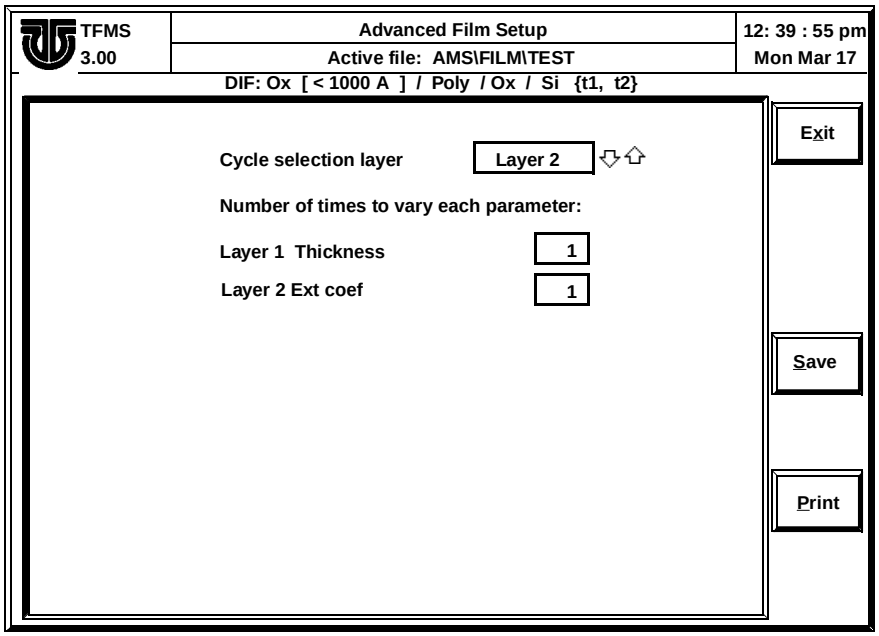
Figure 6.17 Advanced film setup window



Cycle selection layer:Cycle selection is a calculation feature that determines the thickness range for a film layer. This film layer is usually the top one. However, if the second layer requires the use of the spectrometer (e.g, polysilicon in DIF: Ox/Poly/Ox/Si), it is this layer that requires cycle selection. You can perform cycle selection on either the first or second film layer. When you select the *Cycle selection layer* field, a pop-up menu appears with either two or three options: *None* and *Layer 1* for a 1 layer film or a 2 layer film when the bottom film thickness is known (not calculated), *None*, *Layer 1*, and *Layer 2* for a 2 layer film when the thickness of the two layers are measured, and *None*, *Layer 1*, and *Layer 2* for a 3 layer film when the thickness of the first(top) and second(middle) layers are measured. In the example in Figure 6.17, the system performs cycle selection on the poly Si layer (Layer 2), and you can specify the number of times to vary each of the additional measured parameters in the *Layer 1Thickness* and *Layer 2 Ext coef* fields. If you select *None* in the *Cycle selection layer* field, the system does not perform cycle selection and you can specify the number of times to vary all of the measured parameters.

Number of times to vary each parameter :Specifies how the calculation searches between the minimum and maximum values entered in the Fit parameters window. The routine uses the specified number of times (n) to vary each parameter to divide the minimum - maximum range in n equal size trial ranges. The system

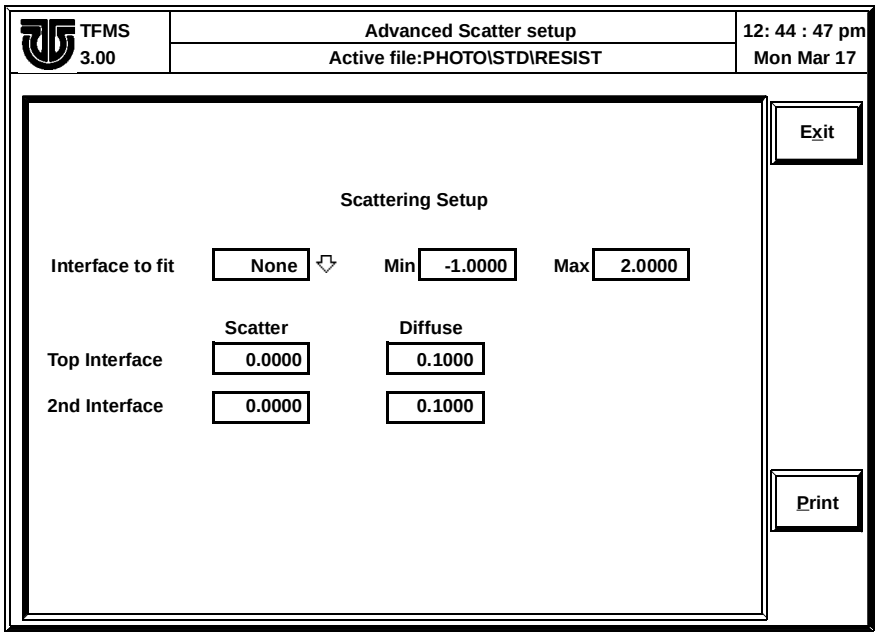
searches for the best fit independently in each trial range and the measurement results correspond to the best overall fit. Although the calculation takes longer for n>1 than for n=1, with this procedure you can find the correct solution for multi-layered films (when several solutions can compete) and optimal values for the nominal parameter entries.

Additional details on using the Advanced film setup window are covered in Therma-Wave's advanced applications course.

Scatter button

When you select the *Setup*/*Recipe*/*Film*/*Fitting*/*Scatter* button, the Advanced Scatter setup window appears, as shown in Figures 6.18 and 6.19 for non-spectrometer and spectrometer measurements. For details on selecting a spectrometer measurement, see the Advanced Calculation Parameters, earlier in this section. Two contributions to interface scattering are included in the film thickness calculation. Scatter specifies how much light is scattered from the incident beam. Diffuse specifies how much of the scattered light remains in the beam as a diffuse component and returns through the objective lens; there are separate diffuse coefficients for the laser and the white light. The combined effect of these contributions changes the shape of the A and B (s and p polarization) profiles. Scattering is only important for certain films, such as polySi, and Aluminum.

Figure 6.18 Advanced Scatter setup window (non-spectrometer measurement)



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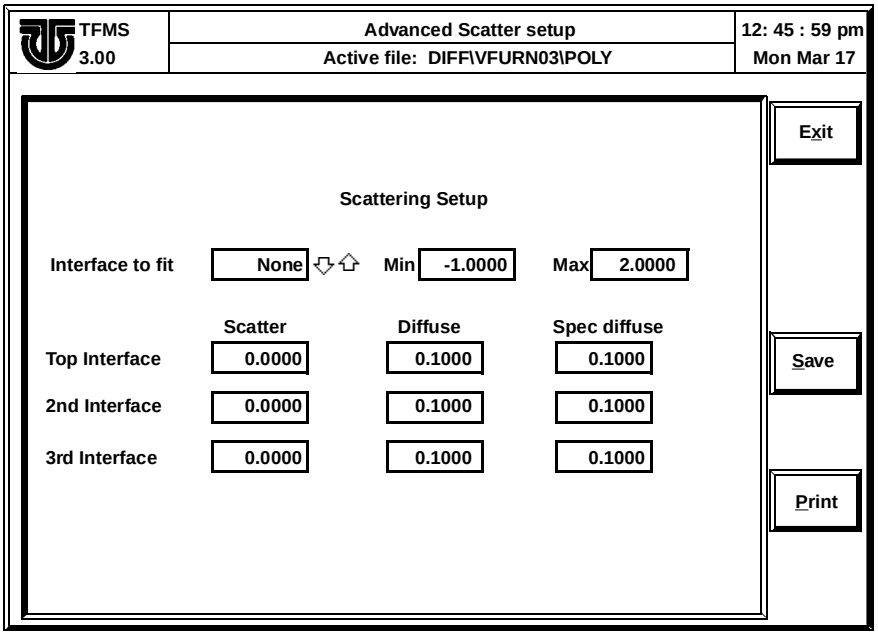
Exercise caution before editing any values in this window. Normally, Therma-Wave's default values are appropriate. For more information, contact Therma-Wave Applications Staff or attend the advanced applications course.

Figure 6.19 Advanced Scatter Setup window (spectrometer measurement)



Interface to fit: Specifies the interface where the scattering coefficient is fit. When you select this field, a pop-up menu appears where you select the interface, as shown in Figures 6.20 and 6.21. The list of interfaces depends on the number of films in the film stack.t

Figure 6.20 Interface to fit pop-up menu (single-layer film)

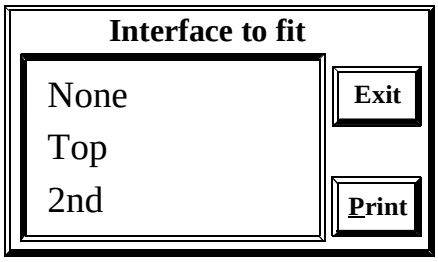


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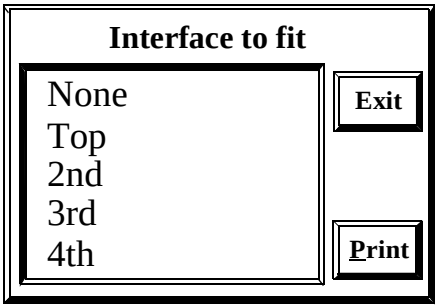
Figure 6.21 Interface to fit pop-up menu (three-layer film stack)



Following is a description of each option:

- None indicates that the scattering coefficient is not fit (i.e., calculated).
- Top is the interface between air and the (top) film layer.
- 2nd is the interface between the film and the substrate (single-layer film), or between the top film and the bottom film (two-layer film stack), or between the top film and the middle film (three-layer film stack).
- 3rd is the interface between the bottom film and the substrate (two-layer film stack), or between the middle and bottom films (three-layer film stack).
- 4th is the interface between the bottom film and the substrate (three-layer film stack).

Min, Max:Specify minimum and maximum values for the scattering coefficient to be fit. Normally, Therma-Wave's default values are optimum.

Scatter:For the selected interface to fit, specifies the nominal value for the scattering coefficient. For other interfaces, specifies a fixed value for the scattering coefficient. Normally, Therma-Wave's default values (0.0) are optimum.

Diffuse:Specify the fraction of the scattered laser light that undergoes diffuse reflection and returns through the objective lens. These values are fixed. Normally, Therma-Wave's default values (0.1) are optimum.

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Spect diffuse: Specify the fraction of the scattered white light that undergoes diffuse reflection and returns through the objective lens. These values are fixed. Normally, Therma-Wave's default values (0.1) are optimum.

Dsprsn button

The *Setup*/*Recipe*/*Film*/*Fitting*/*Dsprsn* button is described after the *Setup*/*Recipe*/*Film*/*Mtrl* button, which is discussed next. After you learn about dispersion models in the Material characterization window, you will gain a better understanding of the Fitting/Dsprsn button's functionality.

The initial release of TFMS 3.00 may not include a *Dsprsn*(Dispersion) button or any of the dispersion parameters, described later in this section. Future TFMS 3.00 upgrades will include the *Dsprsn* button and its associated features.

Mtrl button

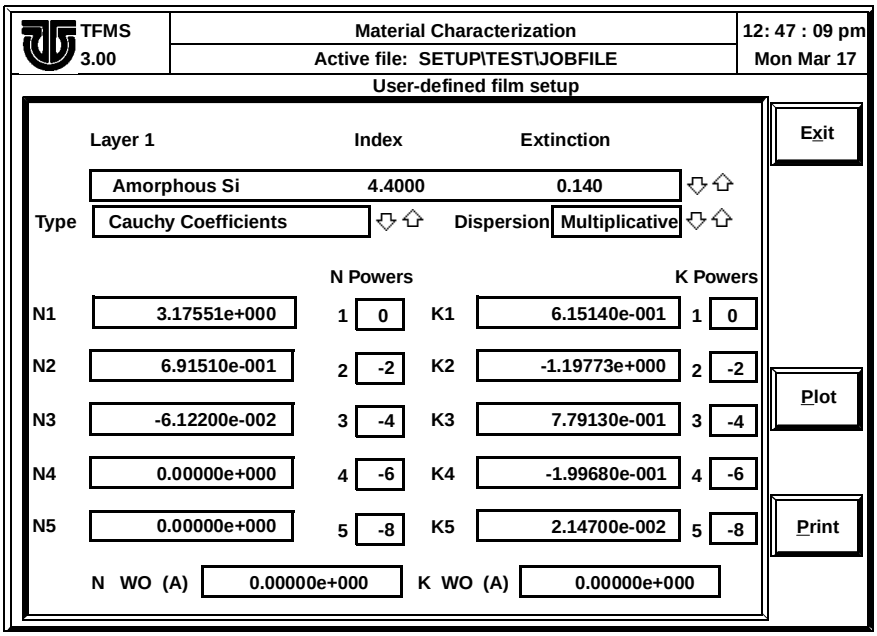
The initial release of TFMS 3.00 may not include a *Mtrl* button or any of the Material Characterization parameters described next in this section. Future TFMS 3.00 upgrades will include this button and its associated features.

When you select the *Setup*/*Recipe*/*Film*/*Mtrl* button, the Material Characterization window appears, as shown in the example in Figure 6.22. In this window, you can set up your dispersion model for each film layer and the substrate. Dispersion defines how the optical parameters (N and K) vary with the wavelength. Therefore, the *Mtrl* button is only relevant for spectrometer measurements, especially in the UV range. The parameters in this window can extend the measurement capabilities for both UV and non-UV systems. For UV systems, the gains are especially significant, as described in Section 5, "DUV Functions." Typically, the dispersion parameters remain fixed during a job file run.

When you open this window for the first time, the Cauchy coefficients appear as the default characterization type. A *Plot* button appears in the right margin, which

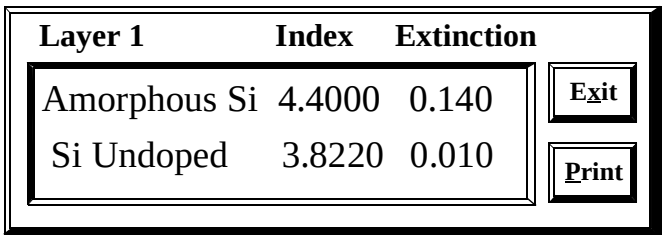
allows you to graphically display the optical dispersion of each layer and the substrate, as shown later in this section.

Figure 6.22 Material Characterization window



Layer, Substrate: Specifies the desired film layer or substrate and the corresponding film index and extinction coefficient. When you select this field, a pop-up menu appears with the appropriate options, as shown in the example in Figure 6.23 for a 1 layer film.

Figure 6.23 Film layer/Substrate pop-up menu



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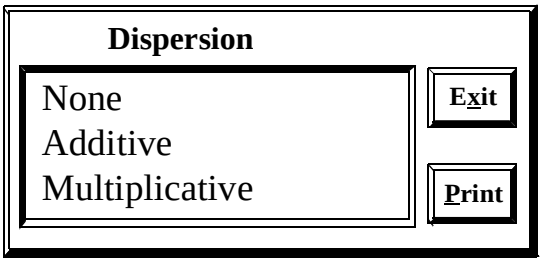
Dispersion: When you select this field, a pop-up menu appears with three options, *None*, *Additive*, and *Multiplicative*, as shown in Figure 6.24.

Figure 6.24 Dispersion pop-up menu



Additive: Specifies a dispersion curve translated by a constant additive factor, so the curve coincides with the known value of the index or extinction coefficient at the laser wavelength. Typically, you use this option for the UV range.

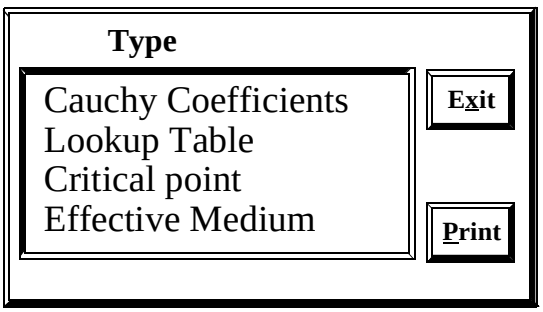
Multiplicative: Specifies a dispersion curve scaled by a constant multiplicative factor, so the curve coincides with the known value of the index or extinction coefficient at the laser wavelength. Typically, you use this option for the visible range.

None: Specifies no scaling or translation of the dispersion curve.

The above options specify the dispersion scaling, which determines how the N and K parameters agree with their values at the laser wavelength.

Type: Specifies the desired type of material characterization. When you select this field, four options appear in a pop-up menu, *Cauchy Coefficients*, *Lookup Table*, *Critical Point*, and *Effective Medium*, as shown in Figure 6.25.

Figure 6.25 Characterization type pop-up menu



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Following is a description of each of these characterization types:

Cauchy Coefficients :This type of characterization specifies the film stack and substrate Cauchy coefficients used in the spectrometer (and UV, if installed) calculation, as shown in the example in Figure 6.22. The optical constants of all materials vary with wavelength, a property known as dispersion. Cauchy coefficients are used in a simple model or formula for the wavelength (λ) dependence of the index of refraction, n, and extinction coefficient, k, and are typically expressed as follows:

$$n = n_1 + n_2\lambda^{-2} + n_3\lambda^{-4} + n_4\lambda^{-6} + n_5\lambda^{-8}$$

$$k = k_1 + k_2\lambda^{-2} + k_3\lambda^{-4} + k_4\lambda^{-6} + k_5\lambda^{-8}$$

In these formulas, n_j and k_j are the Cauchy coefficients. These formulas are valid over a somewhat limited wavelength range which may depend on the number of terms. Extrapolation outside the intended wavelength range can result in incorrect dispersion curves.

N powers/K powers 1-5, N WO (A) /K WO (A):
The N powers and K powers specify the exponential factors for wavelength in the Cauchy expansion. N WO (A) and K WO (A) specify an additional wavelength offset in the Cauchy expansion. This leads to a more general expression than a true Cauchy expansion where N WO (A) and K WO (A) = 0. The non-zero values provide you with greater flexibility for fitting the data.

In some spectrometer recipes, the system only uses the spectrometer data in the intermediate fitting step for cycle selection purposes (see the description of *Weights* in the Advanced Calculation parameters window). Therma-Wave's default Cauchy coefficients are optimized for use in Opti-Probe systems and may not be the same as those used by other film metrology tools. You should use extreme care in editing these values.

Lookup Table

This type of characterization represents the dispersion of the specified material. When you select this characterization type after selecting a film or substrate with a *Table* entry in the Film parameters window (described earlier), a Lookup Table appears, as shown in the example in Figure 6.26 for Amorphous Si. The Lookup Table displays the index and extinction for a number of different wavelengths

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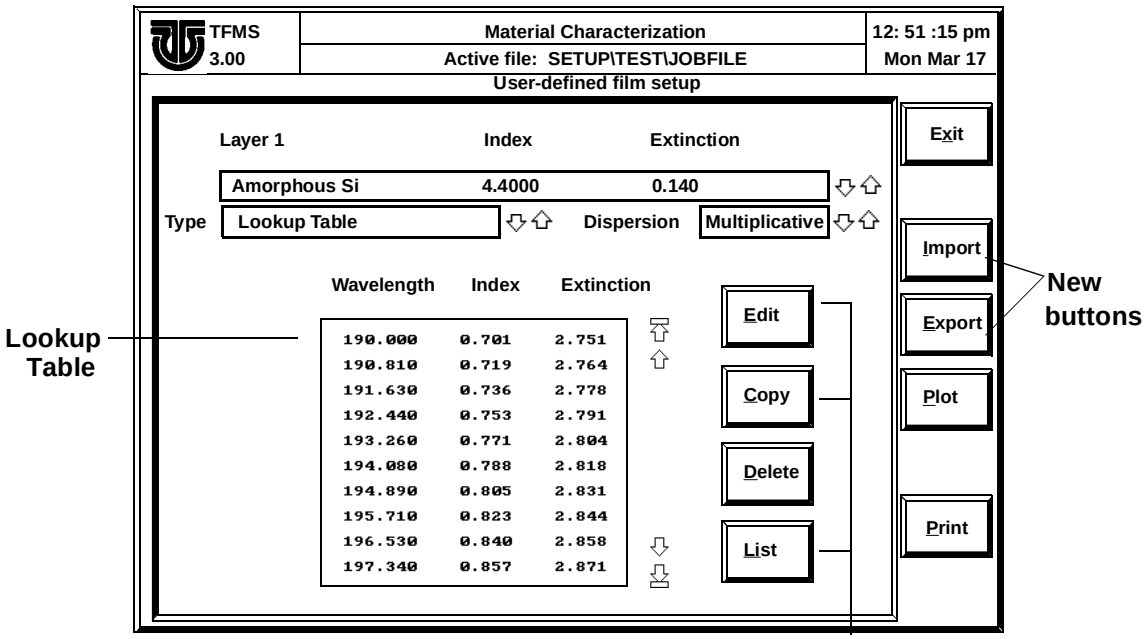
corresponding to the selected film/substrate. If you did not select a film or substrate with a *Table* entry, the Lookup Table is empty. You also see several new buttons, *Import*, and *Export* in the right margin and *Edit*, *Copy*, *Delete*, and *List* next to the Lookup Table.

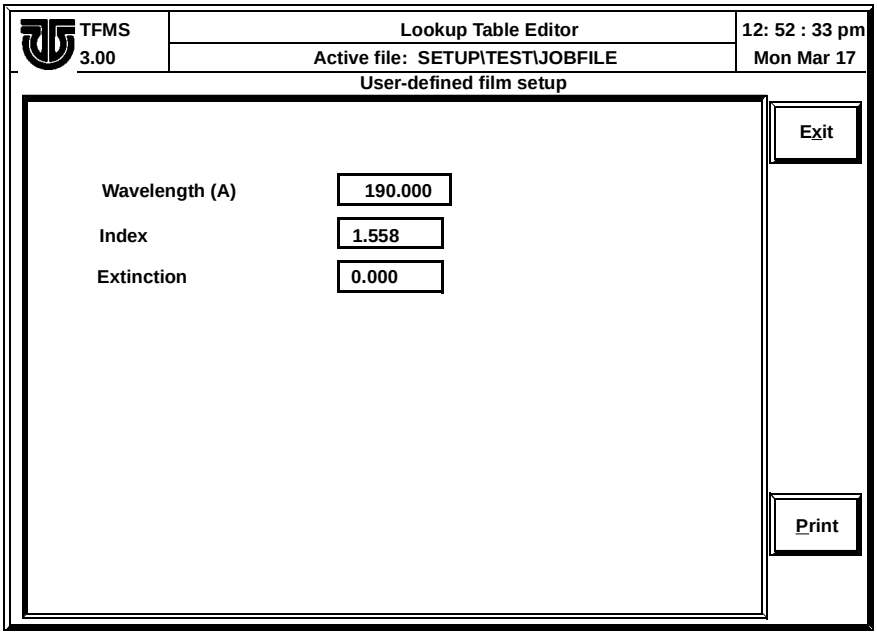
Figure 6.26 Material Characterization window (after selecting Lookup Table as the characterization type



Following is a description of each of the new buttons.

Edit : When you select this button after selecting an entry in the Lookup Table, the Lookup Table Editor window appears with the corresponding wavelength, index, and extinction values, as shown in Figure 6.27. When you select any of these fields, a calculator window appears where you can change any of the values.

Figure 6.27 Lookup Table Editor window



Copy :You can use this button along with the *Edit* button to insert a set of new values between two existing Lookup Table entries. When you select an entry in the Lookup Table and then select the *Copy* button, the system inserts a new entry with identical values below your selection. You can change these values using the *Edit* button , as described above.

Delete :When you select this button after selecting an entry in the Lookup Table, the system deletes the entry.

List :When you select this button, the system prints a copy of the Lookup Table.

Export :This button allows you to copy the currently displayed Lookup Table to a floppy disk. When you select this button, a dialog box appears that asks you to insert a DOS formatted disk. After you insert the disk and select *Ok* in the dialog box, a keyboard window appears where you enter a name for the Lookup Table you want to export. After you enter the name, the system copies the current Lookup Table to your floppy disk with your specified name.

Import:This button allows you to copy a Lookup Table from a floppy disk when the currently displayed material does not contain one *(empty* entry in table). If this is the case, when you select the *Import* button in the Material

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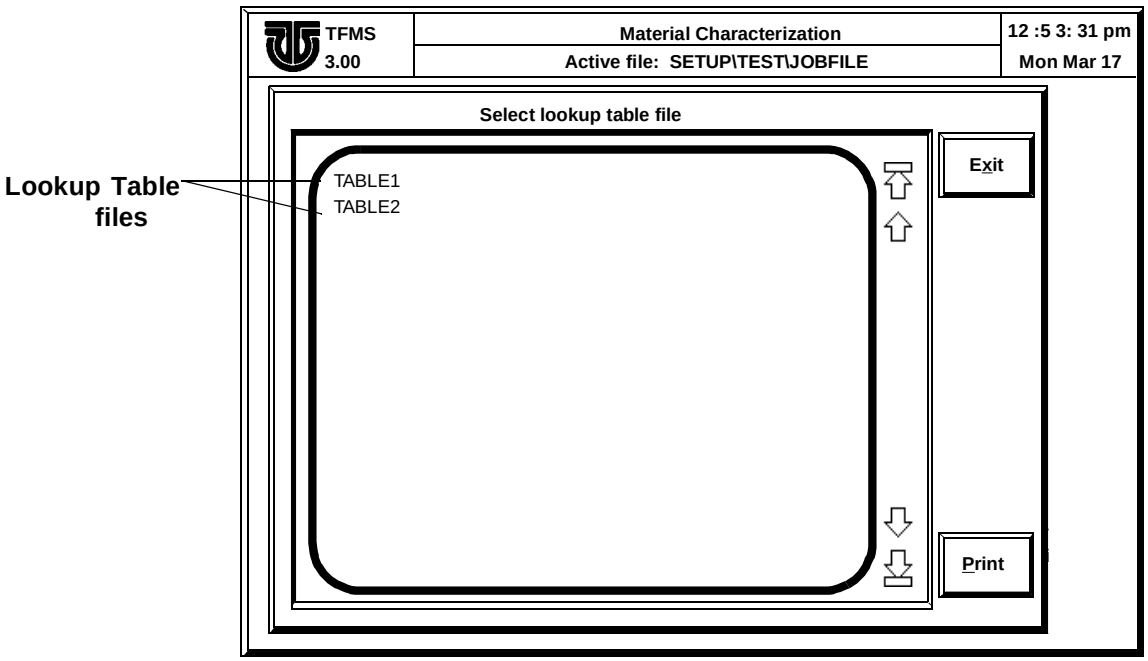
Characterization/Lookup Table window, a dialog box appears that asks you to insert a DOS formatted disk. After you insert the disk and select *Ok* in the dialog box, the Select lookup table file window appears with a list of the files on the floppy disk, as shown in the example in Figure 6.28. When you select a Lookup Table file in this window, the system copies that Lookup Table to the currently displayed material in the Material Characterization/Lookup Table window (replacing the *empty* entry).

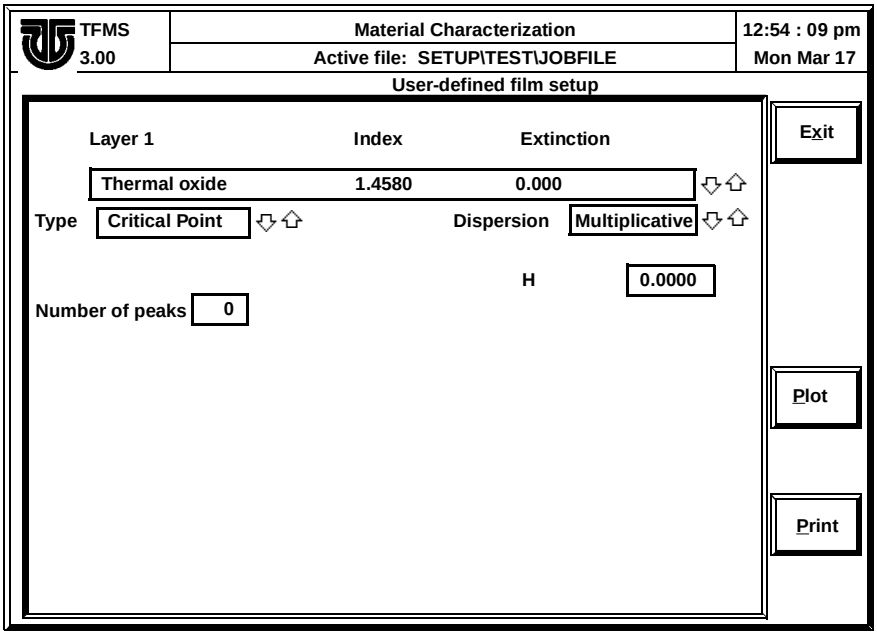
Figure 6.28 Select lookup table file window



Critical Point (oscillator model)

This type of characterization defines dispersion in terms of one or more resonant absorbing energies. When you select this option, the Material Characterization window looks similar to the example in Figure 6.29. In this window, you see new data entry fields for *H* and *Number of peaks*.

Figure 6.29 Material Characterization window (after selecting Critical Point as the characterization type)



Following is a description of the Critical Point parameters.

H: Specifies the asymptotic value of the dielectric function as the frequency approaches infinity.

Number of peaks : This type of characterization specifies the number of oscillators (peaks) in the dispersion model. When you select a film layer and then enter a number in this field, the corresponding number of peaks appear, as shown in the example in Figure 6.30 with 1 peak selected.

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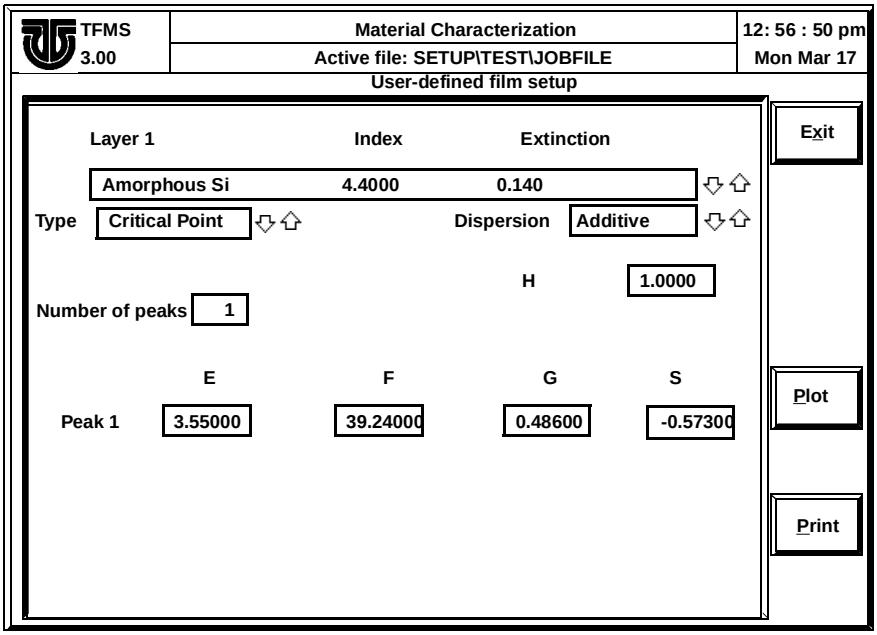
Figure 6.30 Material Characterization window (after selecting Critical Point as the characterization type and 1 as the number of peaks)



E: Specifies the resonance/absorption energy for each peak.

F: Specifies the oscillator strength for each peak.

G: Specifies the damping constant for each peak.

S: Specifies the phase of the oscillator strength for each peak.

Effective Medium

This type of characterization specifies a fractional composition of two or three different films, e.g., poly as a fraction of Si Undoped and Amorphous Silicon. When you select this option, the Material Characterization window looks similar to the example in Figure 6.31, which shows the system's default entries. In this window, you see a new data entry field for *Number of components* and a *Comp* (component) button in the right margin.

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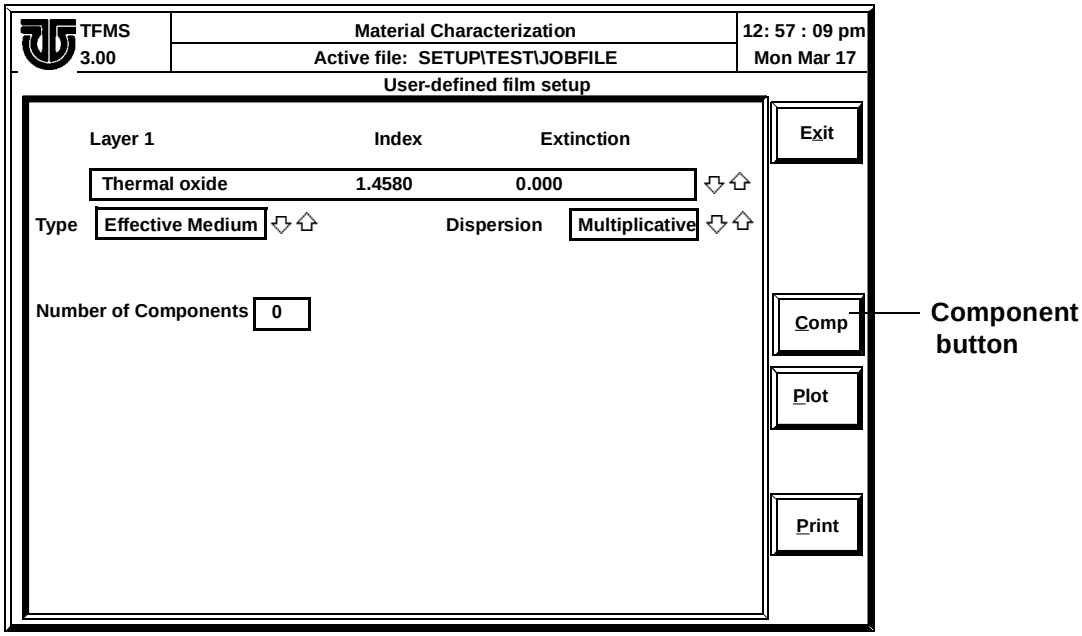
Figure 6.31 Material Characterization window (after selecting Effective Medium as the characterization type)



Number of components :This parameter specifies the number of components in the fractional composition. When you enter a number in this field, the corresponding number of components appears, as shown in the example in Figure 6.32 with 2 components selected.

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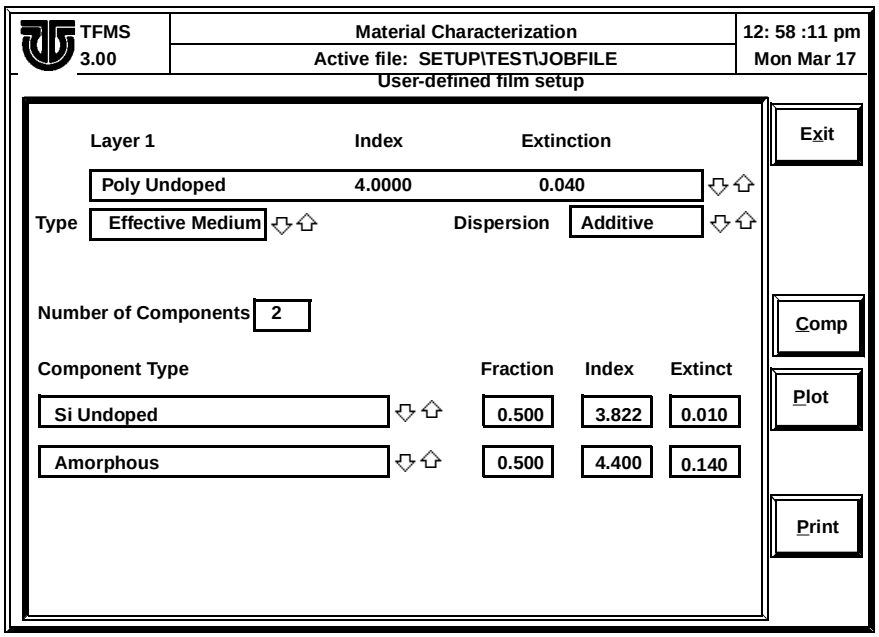
Figure 6.32 Material Characterization window (after selecting Effective Medium as the characterization type and 2 as the number of components)

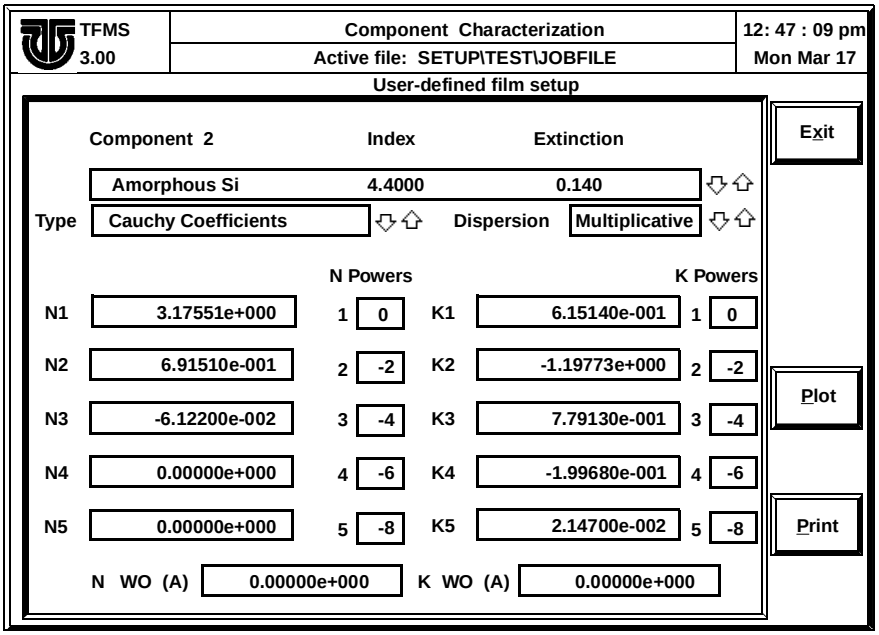


Component Type: Specifies the desired component types for the corresponding number of components.

Fraction: Specifies the fraction occupied by each component in the effective medium.

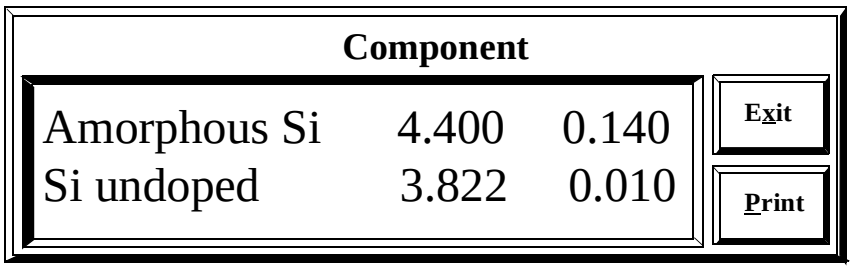
Comp button: When you select this button for an Effective Medium, the Component Characterization window appears, as shown in the example in Figure 6.33. In this window, you select a film component, specify its characterization type and dispersion scaling, and then configure the appropriate parameters (e.g., the N and K values for a Cauchy type, as shown in the example).

Figure 6.33 Component Characterization window (Material characterization type = Cauchy)



Component :When you select this field, the Component pop-up menu appears with a list of the current film components, as shown in Figure 6.34. In this window, you select the component you want to characterize.

Figure 6.34 Component pop-up menu



Plot button:The Plot buttons for all characterization types (and effective medium components) operate identically. When you select any of these buttons, the Plot data entry window appears, as shown in the example in Figure 6.35. In this window, you can set up a Dispersion Plot. A *Go* button appears in the right margin.

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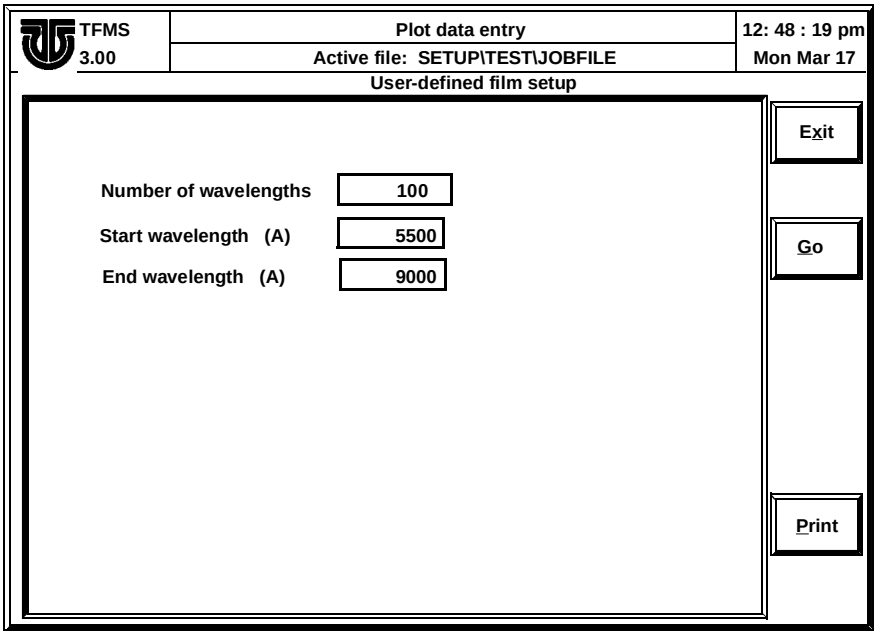
Figure 6.35 Plot data entry window



Following is a description of the Dispersion Plot parameters.

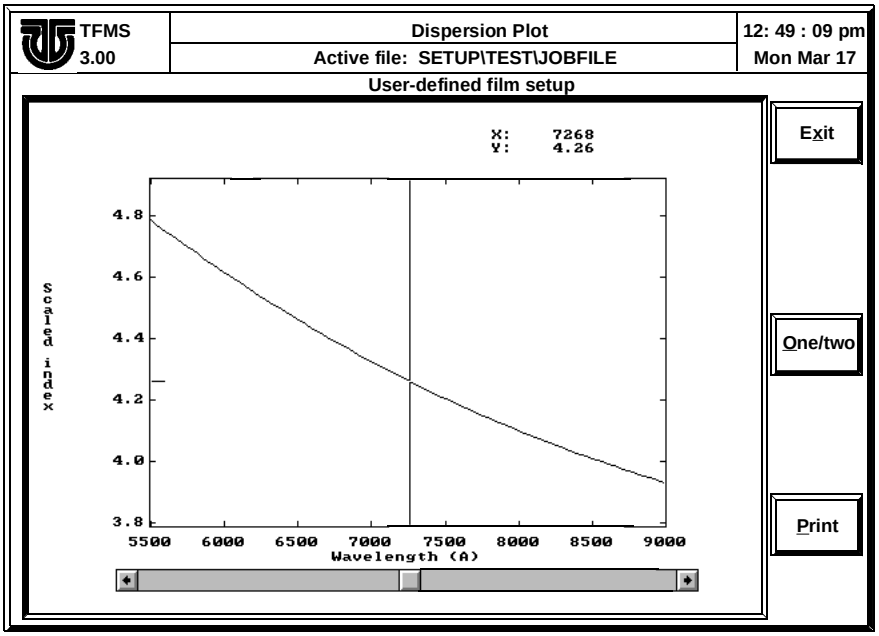
Number of wavelengths: Specifies the number of points (wavelengths) in the plot.

Start wavelength (A): Specifies the starting wavelength in the plot.

End wavelength (A): Specifies the ending wavelength in the plot.

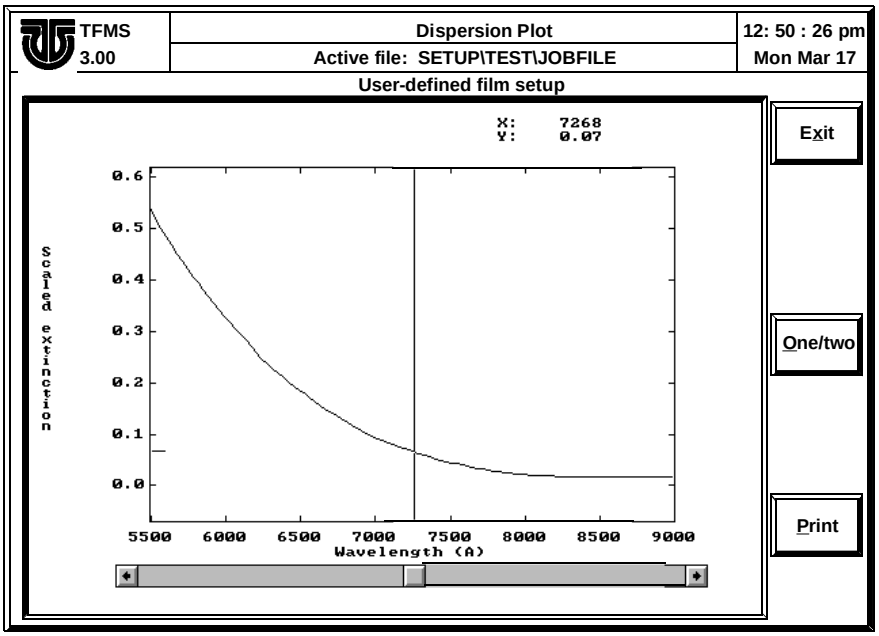
Go button: When you select this button for any characterization type, the Dispersion Plot window displays an index curve (scaled index vs. wavelength). The example in Figure 6.36 shows a Cauchy Coefficients plot.

Figure 6.36 Dispersion Plot window (Index curve)



Exit button: When you select the *Exit* button, the Dispersion Plot window displays an extinction (k) curve (scaled extinction vs. wavelength), as shown in the example in Figure 6.37.

Figure 6.37 Dispersion Plot window (Extinction (k) curve)



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The initial release of TFMS 3.00 may not include a *Dsprsn*(Dispersion) button or any of the dispersion parameters. Future TFMS 3.00 upgrades will include this button and its associated features.

Setup/Recipe/Film/Fitting/Dsprsn button: When you select the *Dsprsn* button in the Fit Parameters window, the Dispersion Fitting window appears, as shown in the examples in Figures 6.38, 6.39, and 6.40 for each of the Material characterization types (except Lookup Table, which has no dispersion fitting). In this window, you select a film layer to fit the optical dispersion, and then select *Yes* or *No* to specify which parameters the system fits. You typically use this function only for UV spectrometer measurements, and for optimizing the dispersions of N and K for a film in the UV range. Because this function applies new measurement parameters, exercise caution when you use it. You should select only a few of these parameters at a time, and update the entries later so you use fixed (not calculated) dispersion in your measurement setup.

Figure 6.38 Dispersion Fitting window (Material characterization type = Cauchy)

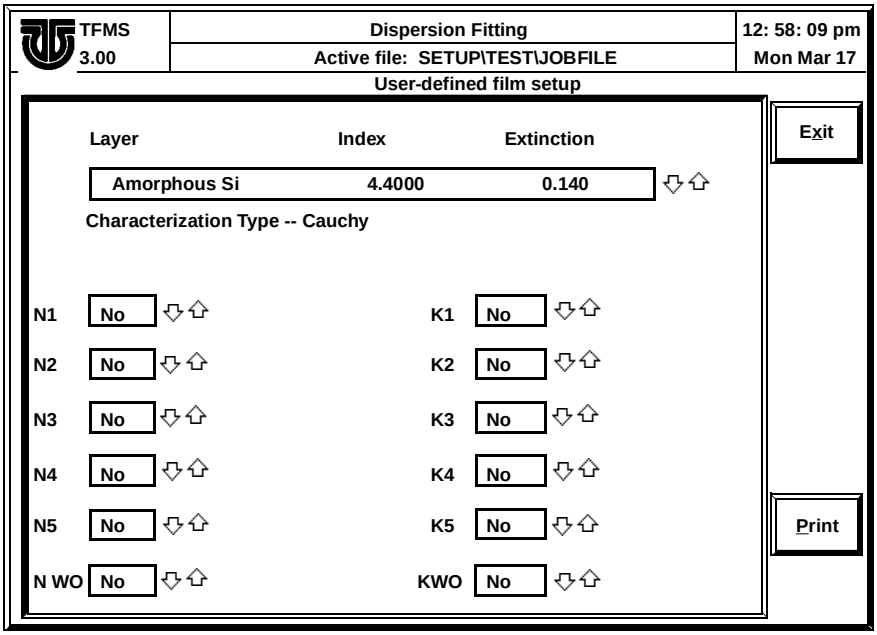


Figure 6.39 Dispersion Fitting window (Material characterization type = Critical Point)

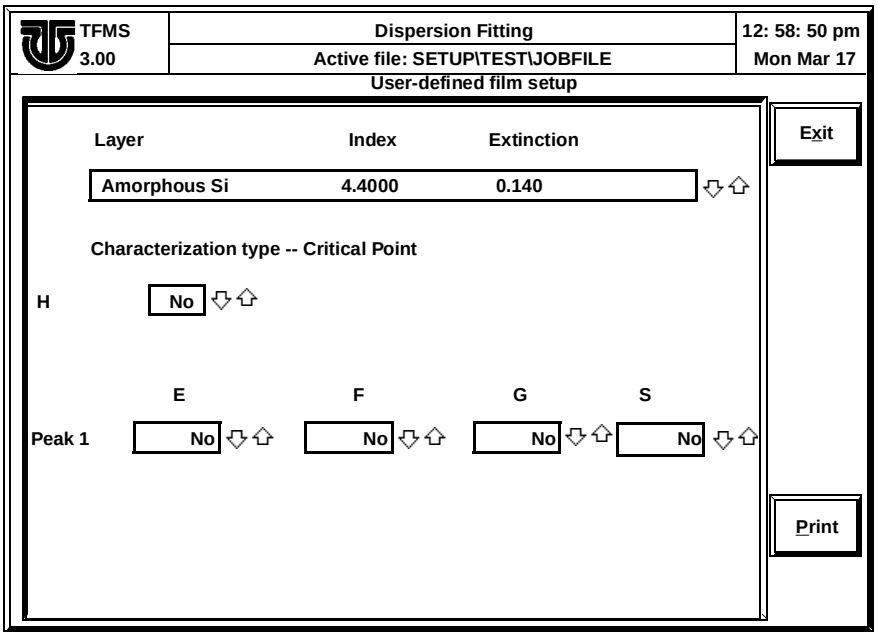
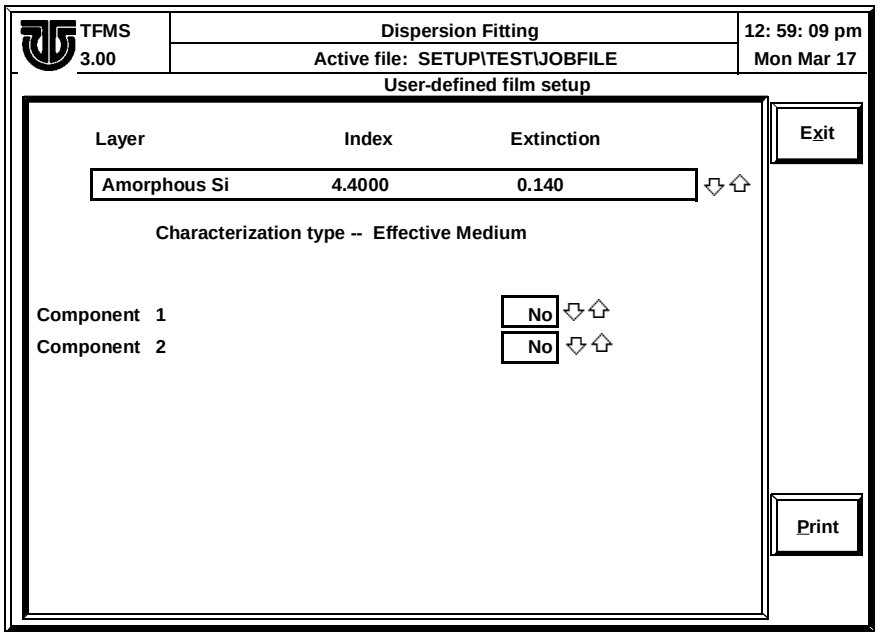


Figure 6.40 Dispersion Fitting window (Material characterization type = Effective Medium)



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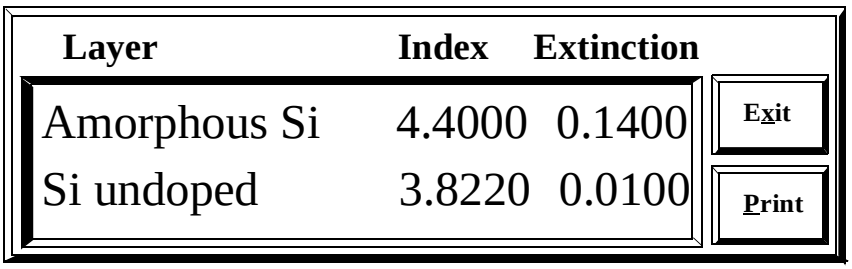
Layer :When you select the *Setup*/*Recipe*/*Film*/*Fitting*/*Dsprsn* button, and then select this field, the Layer pop-up menu appears with a list of the current film layers, as shown in the example in Figure 6.41. You select the desired layer and then select *Yes* or *No* for the characterization parameters to specify which parameters the system fits.

Figure 6.41 Layer pop-up menu

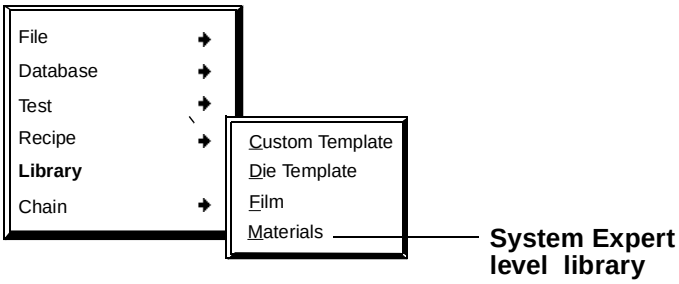


6.3 LIBRARY MENU

When you select *Setup*/*Library* the Library menu appears with a System Expert level library option, *Materials*, as shown in Figure 6.42.

The initial release of TFMS 3.00 may not include a *Setup*/*Library*/*Materials* option or any of the Material Library functions, described next in this section. Future TFMS 3.00 upgrades will include this option and its associated features

Figure 6.42 Layer pop-up menu

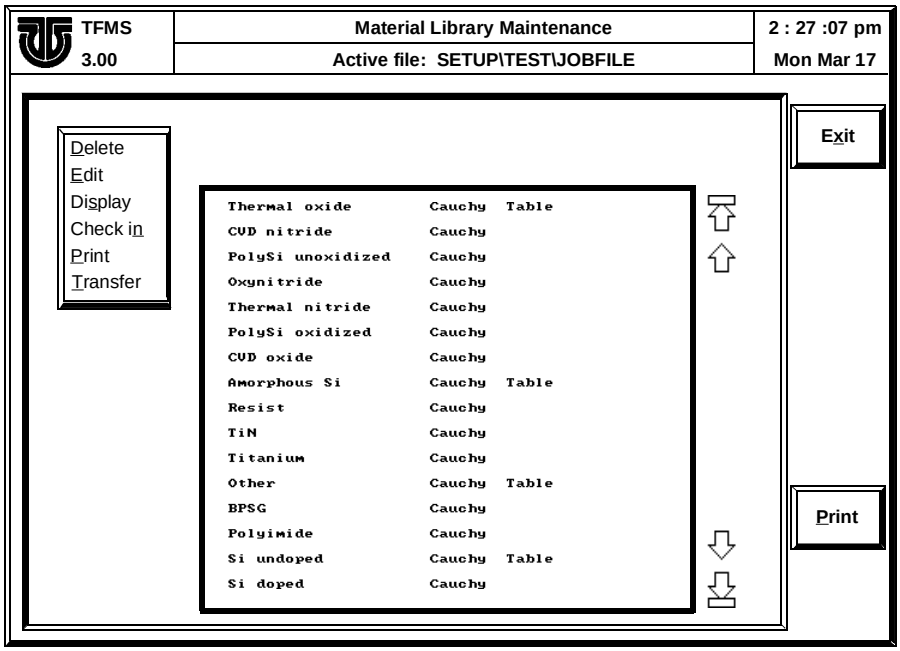


When you select *Materials* in the Library menu, the Material Library Maintenance window appears with a list of materials, as shown in Figure 6.43. In this window, you can add (Check in) the characterized material(s) in your job file's file stack, so

it is accessible to other System Expert level users who can copy it into their job files. You can also modify, display, print, or transfer(copy) a library entry's related data, and rename or delete any of your library entries.

You cannot add Effective Medium type materials to the Material library.

Figure 6.43 Material Library Maintenance window



6.3.1 Materials

Setup/*Library*/*Materials* is similar to the other Setup libraries (e.g., Film and Custom Template), but there are differences. There is no *Filter* button or *Check out* function, the *Check in* and *Edit* functions are different, there is a *Print* option, and you can use the *Transfer* function at the System Expert level.

For a description of the other standard library functions, see Section 3, "Engineer Functions."

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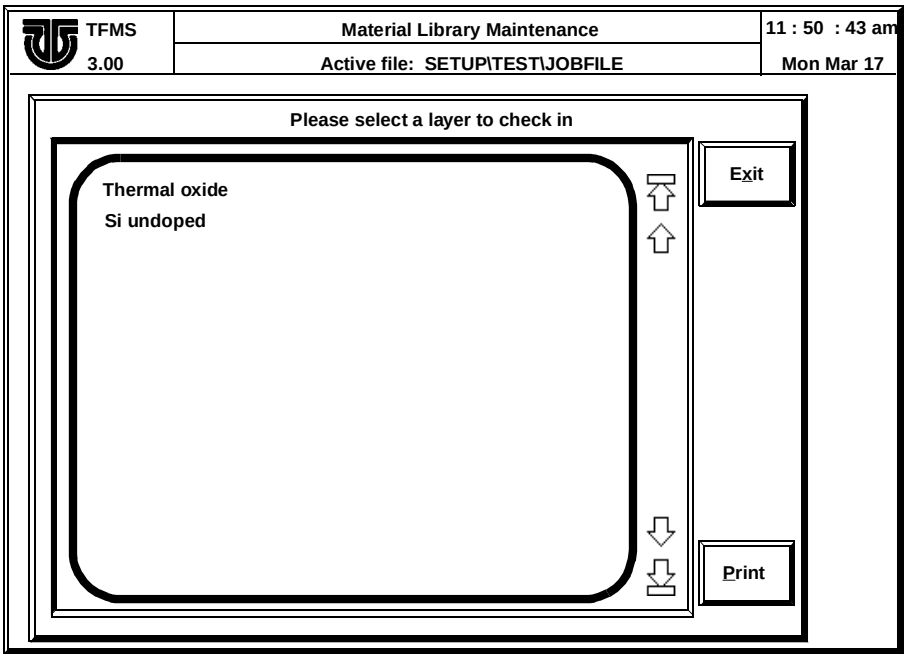
Delete

This option allows the owner (or the System Manager) of a selected material to delete a material from the Materials library.

Check in

When you select this option, the names of the materials in your job file's film stack appear in the Check in window, as shown in the example in Figure 6.44.

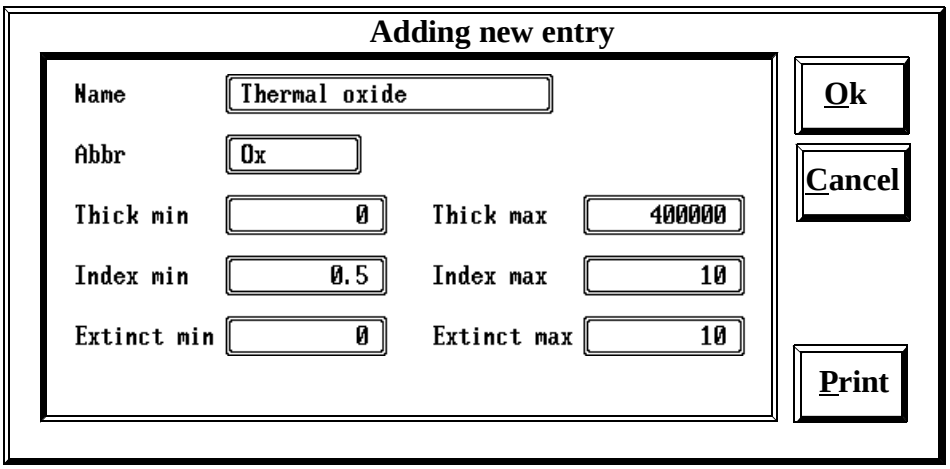
Figure 6.44 Check in window



When you select one of the materials in your film stack, the New entry window appears, as shown in Figure 6.45. In this window, you must re-name the selected material. You can also modify the minimum and maximum values for the material's displayed parameters. The default values are TWI's absolute minimum and maximum values for the selected material. You can modify the absolute values within their current range. After you make your entries and select the *Ok* button, the name of your material appears at the end of the list of materials in the Material Library Maintenance window, and also in the *Setup*/*Recipe*/*Film*/ *Material* (Film/Substrate) windows. At this point, another System Expert level user can select this material in the Film parameters window. After you save your job file

changes, any film stack with a characterized material is available to Engineer and above level users through the regular Film library.

Figure 6.45 New entry window



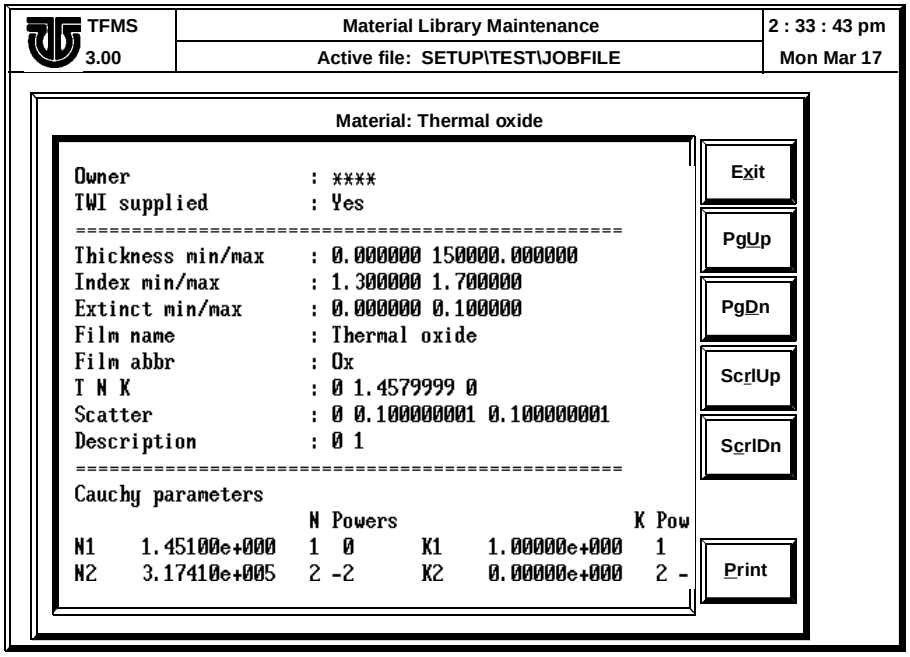
Edit

This function operates the same, and displays the same windows as the *Check in* function, except in this case you can edit your user-defined material that is already checked into the Materials library.

Display

This *Setup*/*Library*/*Materials* option displays the selected material's parameters, as shown in the example in Figure 6.46 for Thermal oxide.

Figure 6.46 Material characterization parameters window



Print

This option prints the selected material's parameters.

Transfer

This option allows you to copy a selected User-defined material, or all User-defined materials (at one time) to or from a floppy disk. You cannot copy TWI-defined materials.

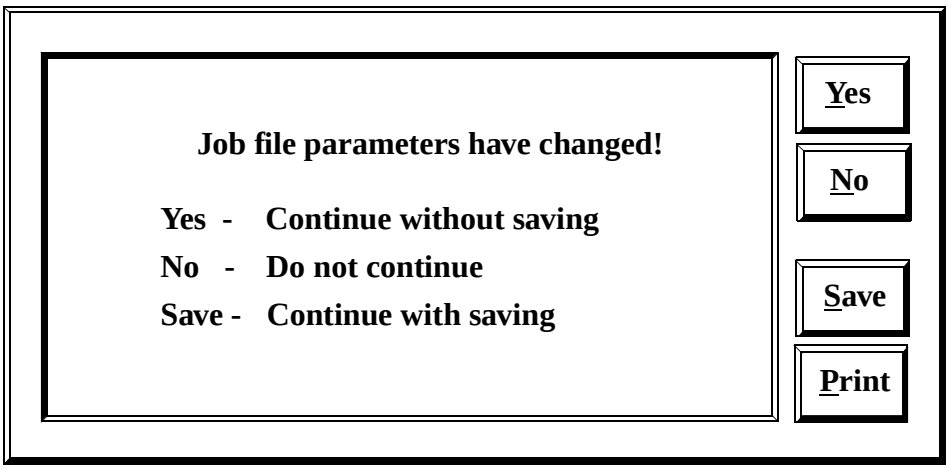
For more information on the Transfer functions, refer to the next section on System Manager Transfer Library operations.

6.4 LOGGING OUT

When you're finished using the System Expert functions, select the *Exit* button to return to the Main Menu window, and then select the *Logout* button. This returns the system to the Operator level and secures it against unauthorized use. If you do not have change privileges for the job file, the system closes the job file and logs you out.

If you have change privileges for the job file and did not change any parameters during the current login, the system logs you out. If you have change privileges for the job file and did change any parameters, a dialog box appears with a warning message, as shown in Figure 6.47. Select *Yes* to continue without saving your changes, *No* to cancel the Logout, or *Save* to save your changes. If you select *Yes* or *Save*, the system logs you out accordingly and either closes the job file or keeps it open, as specified by the System parameters. If a job file remains open with unsaved changes, none of these changes are saved when a user opens another job file.

Figure 6.47 Job file parameters changed dialog box



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7

SYSTEM MANAGER FUNCTIONS

Contents

- Setup menu 7-3
- Library menu 7-8
- Administration menu 7-13
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- Job file management 7-47
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This section describes the Opti-Probe's System Manager level functions. This level of TFMS provides the highest access privileges to the system. If youhave a System Manager level User ID, you can access all the Operator, Engineer, and System Expert functions. In addition, you can perform administrative tasks, which include the following operations:

- Test parameters setup
- User ID and access control
- System parameters control
- Library maintenance
- Tape backup
- Hard drive maintenance
- Diagnostics control
- Wafer imprint reader control
- Signal tower management
- SECS parameters setup
- Job file management

This section assumes that you already know how to perform all Opti-Probe operations described in the previous sections of this manual.

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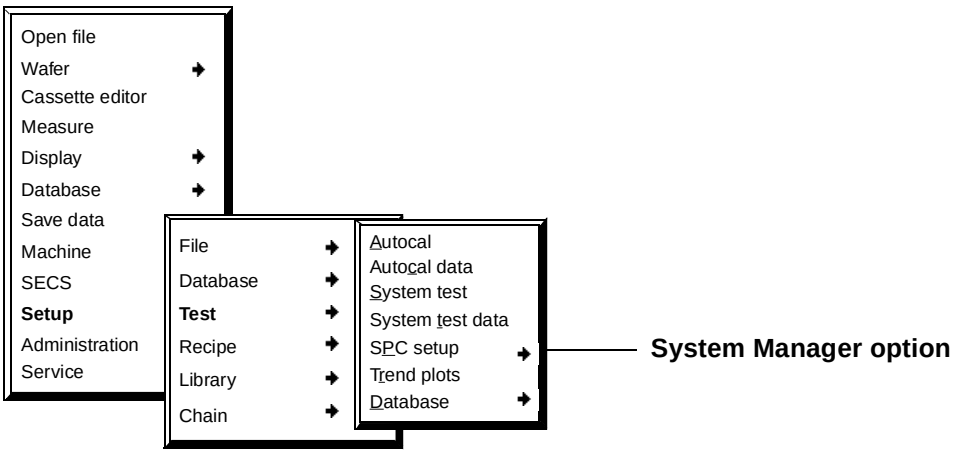
7.1 SETUP MENU

At the System Manager level, when you select *Setup*/*Test*, the *SPC setup* option is now selectable.

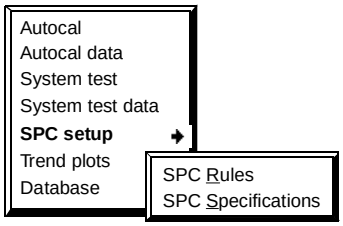
Figure 7.1 Test menu



7.1.1 SPC setup

When you select *Setup*/*Test*/*SPC setup* , two options appear, *SPC rules* and *SPC specifications*, as shown in Figure 7.2. After you set up these parameters, the system displays a warning message when the autocal and system test results deviate from the expected range.

Figure 7.2 SPC setup menu

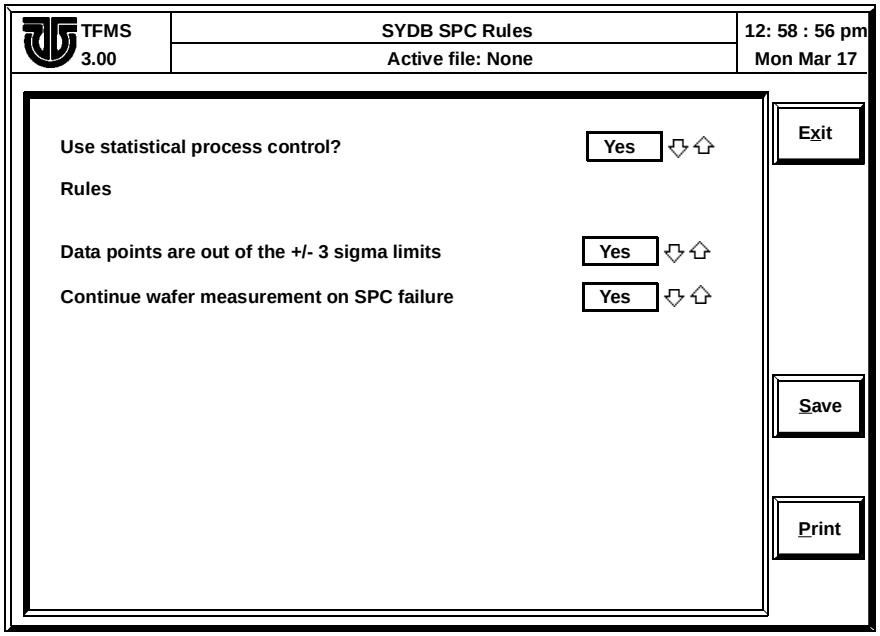


SPC rules

When you select *SPC rules* in the SPC setup menu, the System test database SPC Rules window appears, as shown in the example in Figure 7.3 with statistical process control (SPC) enabled. In this window, you can enable/disable SPC. If

SPC is enabled, you can specify whether the system displays a warning message if one or more points are more than 3 sigma from the target value. You can also specify whether the system continues to measure wafers if there is an SPC violation.

Figure 7.3 System test database SPC rules window



SPC specifications

When you select *Setup*/*Test*/*SPC setup* /*SPC specifications*, the Edit System test database SPC specifications window appears, as shown in the example in Figure 7.4. A Function menu appears in the upper left corner and an SPC specifications list appears in the center. In this window, you can enter SPC specifications for the desired parameter(s). You can also alter or delete the SPC specifications for any parameter(s).

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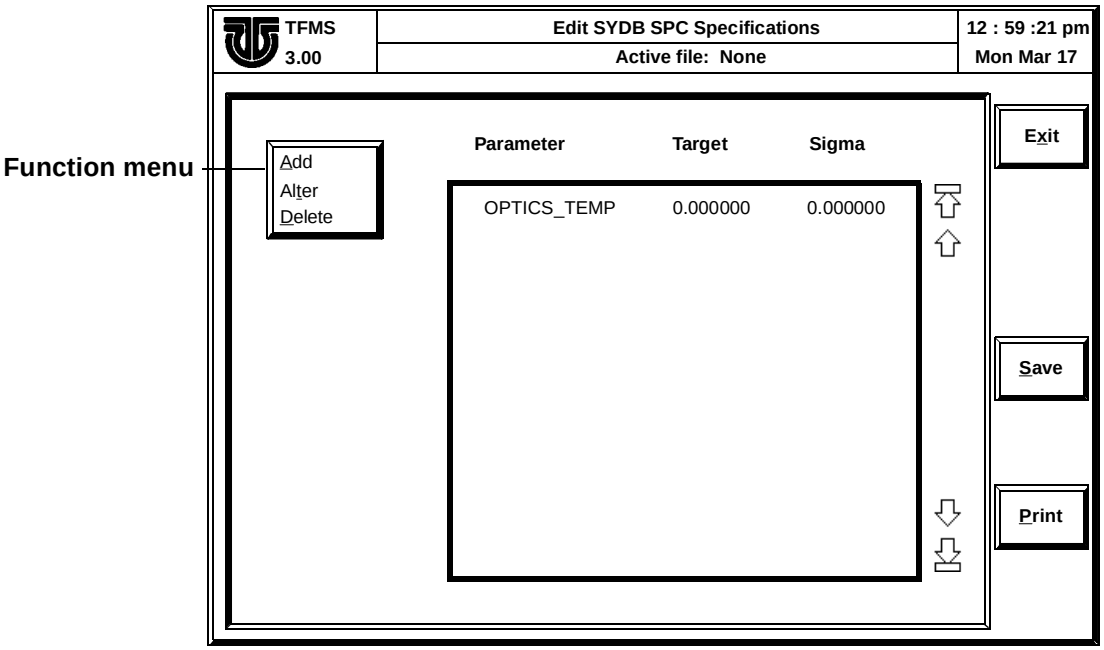
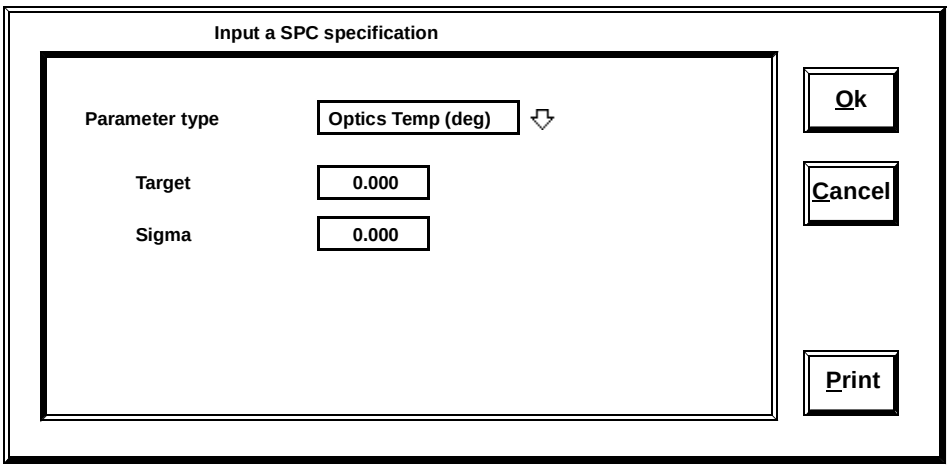
Figure 7.4 Edit System test database SPC specifications window



Add: When you select *Add* in the Function menu, the SPC specifications input window appears, as shown in Figure 7.5. In this window, you can select the desired parameter and its target and sigma values.

Figure 7.5 SPC specifications input window



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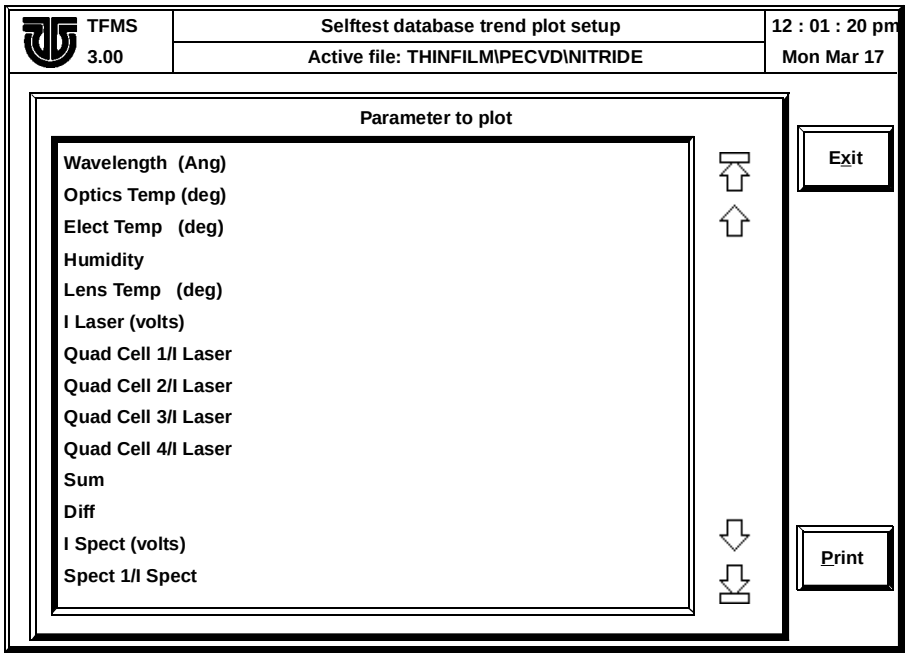
When you select the *Parameter type* field in the SPC specifications input window, a list of selftest parameters appears, as shown in Figure 7.6. You select a parameter and then enter the desired values for that parameter in the *Target* and *Sigma* fields. After entering this information, you select the *Ok* button and the parameter's SPC specifications appear in the SPC specifications list. You repeat this procedure to add any additional SPC parameters.

Figure 7.6 Selftest database trend plot setup window



Alter: To modify an SPC specification, you select a parameter, select *Alter* in the Function menu, and follow the *Add* procedure.

To save your additions or modifications, select the *Save* button in the Edit System test database SPC specifications window. If you exit without saving, a reminder message appears.

Delete: To delete an SPC specification, you select a parameter, select Delete in the Function menu, and then select *Ok* in the confirmation dialog box.

7.1.2 Database menu

At the System Manager level, when you select *Setup*/*Test*/*Database*, the *Delete* and *Setup* options are now selectable, as shown in Figure 7.7.

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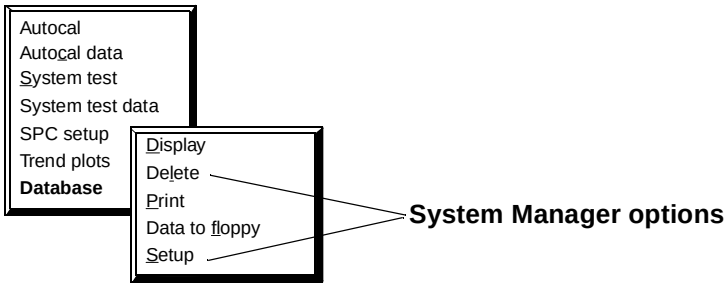
Figure 7.7 Setup/Test/Database menu



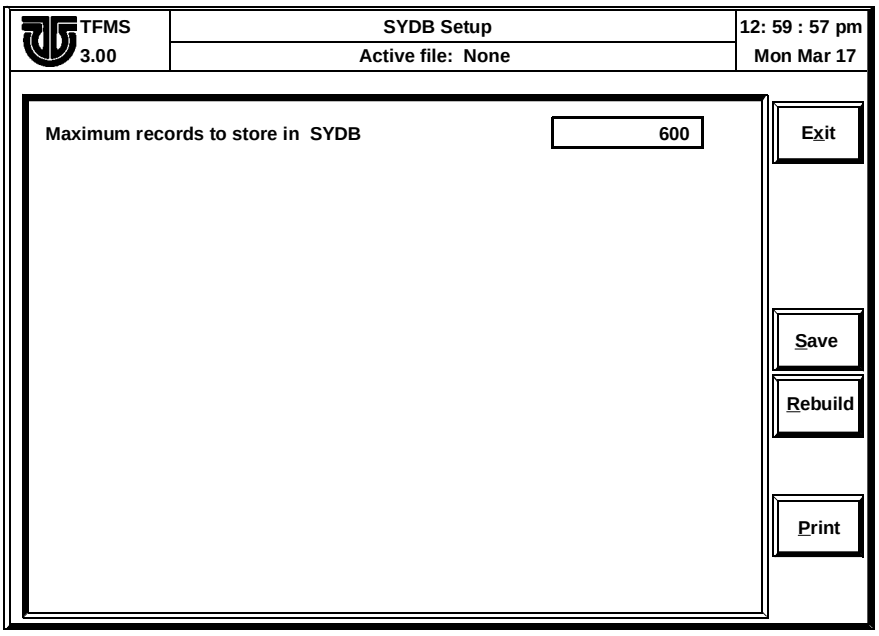
Delete

When you select *Delete* in the Setup/Test/Database menu, all the system test records appear (similar to *Setup*/*Test*/*Database*/ *Display* shown in Section 3, "Engineer Functions"). In this window, you can delete system test records.

Setup

When you select *Setup* in the Setup/Test/Database menu, the System test database setup (SYDB) window appears, where you can specify the maximum number of records to store in the system test database, as shown in Figure 7.8.

Figure 7.8 System test database setup window



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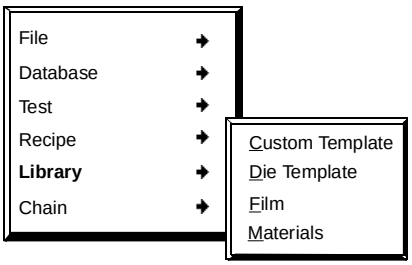
Rebuild button

When you select this button, the system rebuilds the System test database. This process is similar to rebuilding the measurement results database.

7.2 LIBRARY MENU

When you select *Setup/Library*, the Library menu appears with four options, as shown in Figure 7.9.

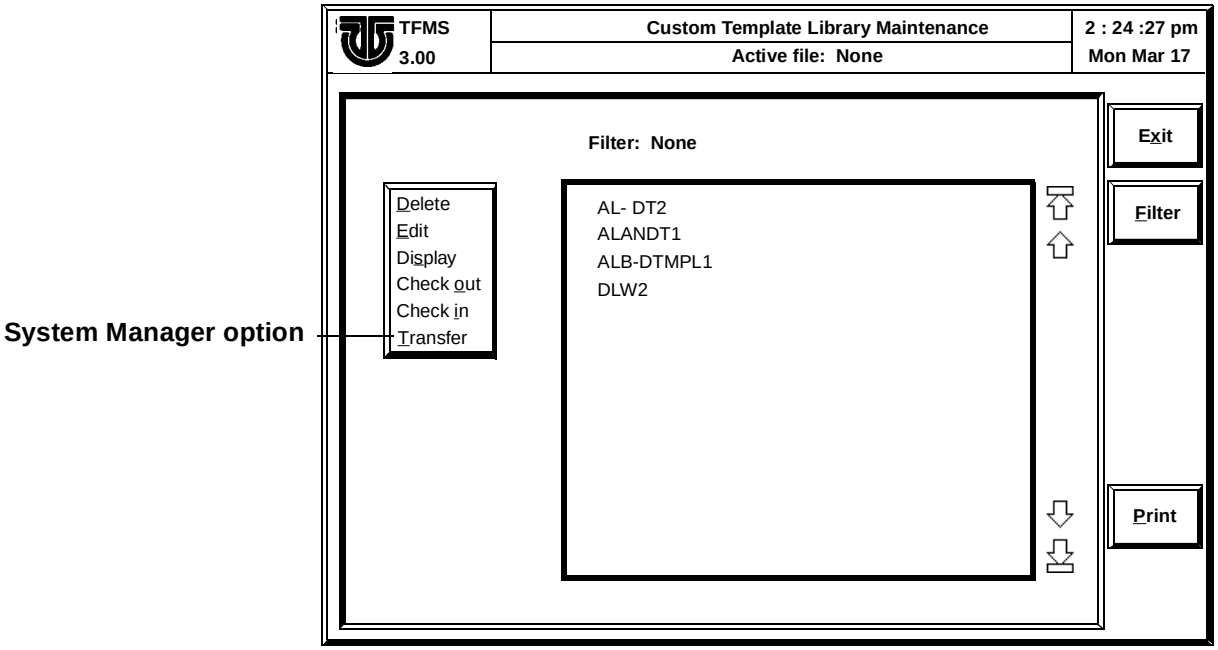
Figure 7.9 Library menu



7.2.1 Custom template/Die template

When you select *Custom Template*, or *Die Template*, the corresponding Library Maintenance window appears with a System Manager option, *Transfer*, as shown in the example in Figure 7.10 for the Custom Template Library. This option allows you to copy library templates to or from a floppy disk.

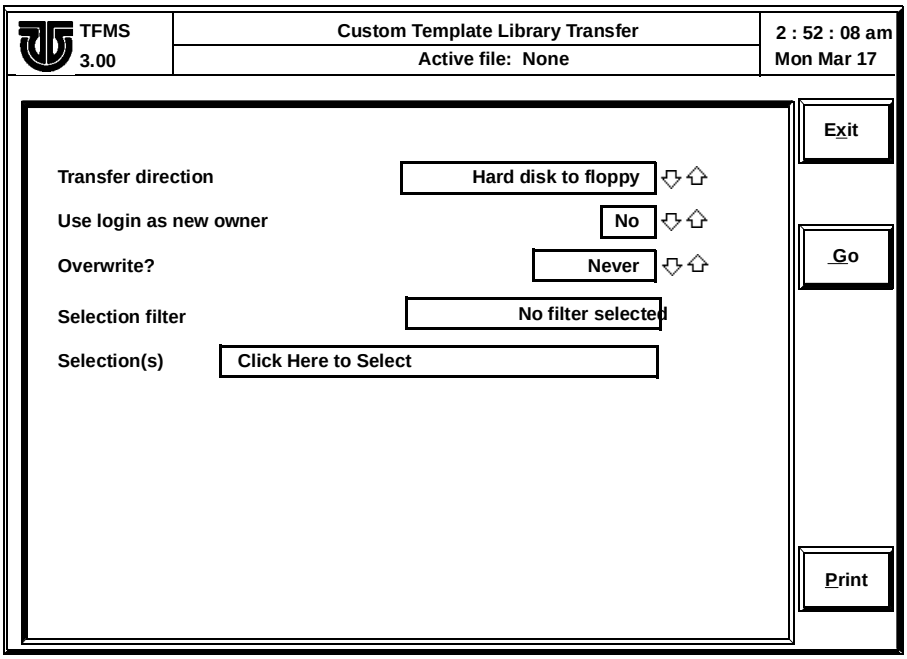
Figure 7.10 Custom Template Library Maintenance window



Transfer

When you select *Transfer* in a Template Library Maintenance window, the Transfer window appears, as shown in the example in Figure 7.11. In this window, you can set up and perform the transfer operation.

Figure 7.11 Custom Template Library Transfer window



Transfer direction: Specifies either a *Hard disk to floppy* or *Floppy to hard disk* transfer.

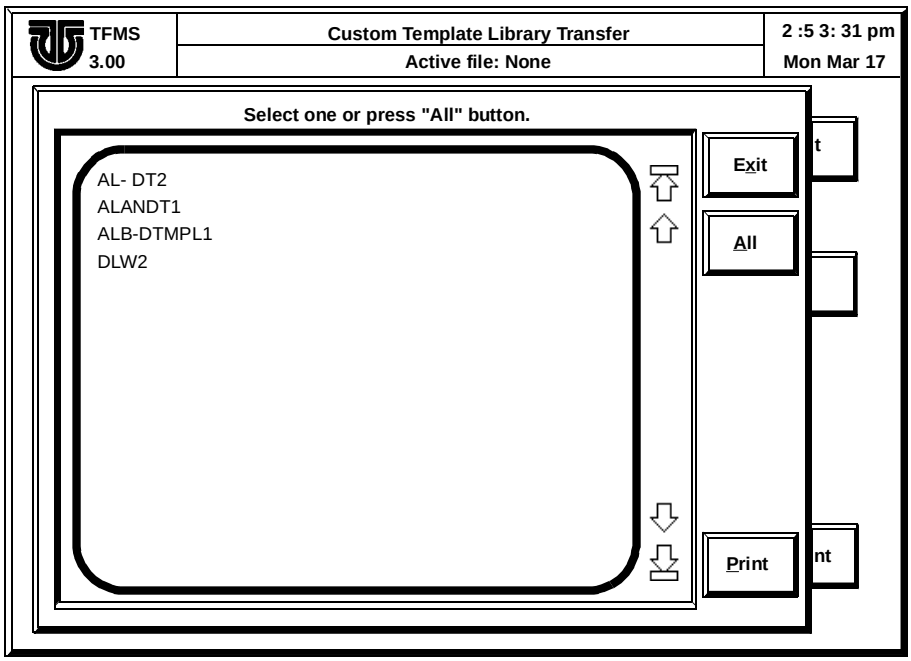
Use login as new owner: Specifies whether to transfer ownership to the currently logged in System Manager.

Overwrite ? Specifies *Always*, *Prompt*, or *Never* (for overwriting a file with the same name).

Selection filter: When you select this field in a Template Library Transfer window, you can enter a selection filter. Filters display only pre-defined selections in the respective libraries (for more information on filtering selections, see Section 3).

Selection(s):When you select this field, the list of library entries appears, as shown in the example in Figure 7.12. In this window you can select a library entry to copy. After you make a selection, it appears in the *Selections* field. You select the *All* button to transfer all the displayed library entries, and *All displayed entries* appears in the *Selections* field.

Figure 7.12 Custom template selection window

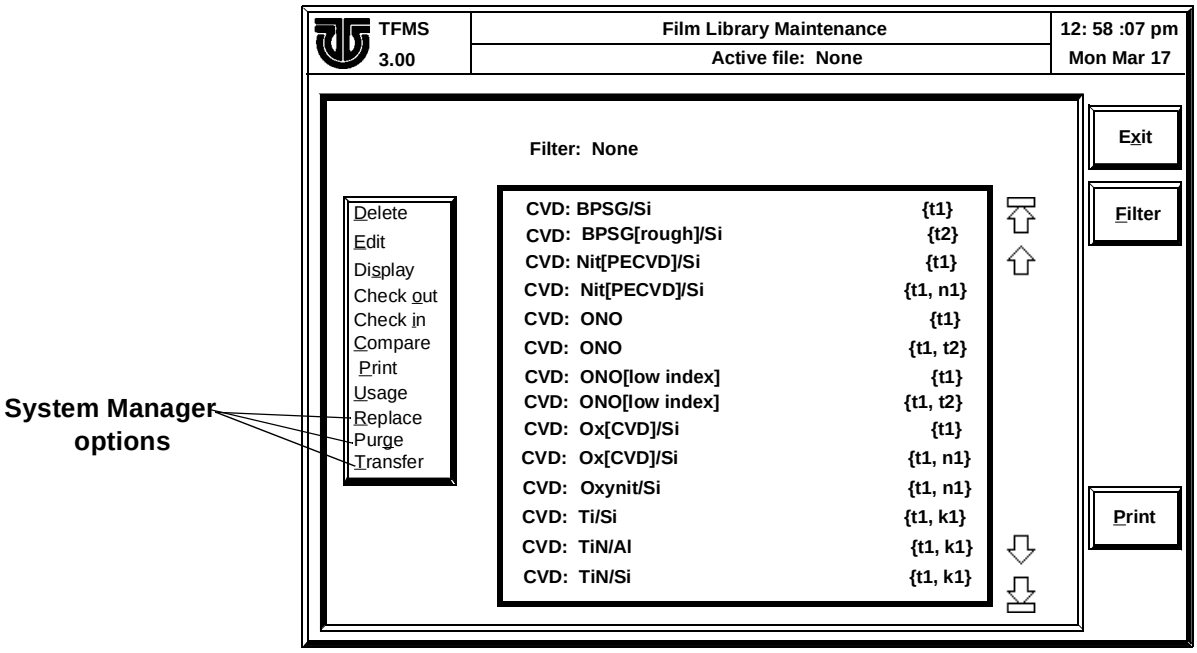


Go button:When you select this button, a dialog box tells you to insert a floppy disk. After you insert a floppy disk and select the *Ok* button in the dialog box, the transfer operation begins. The Status line displays the library entry being copied, and then a confirmation message appears after a successful transfer.

7.2.2 Film

When you select *Setup*/*Library*/*Film*, the Film Library Maintenance window displays three System Manager options in the Function menu, *Replace* , *Purge*, and *Transfer*, as shown in the example in Figure 7.13.

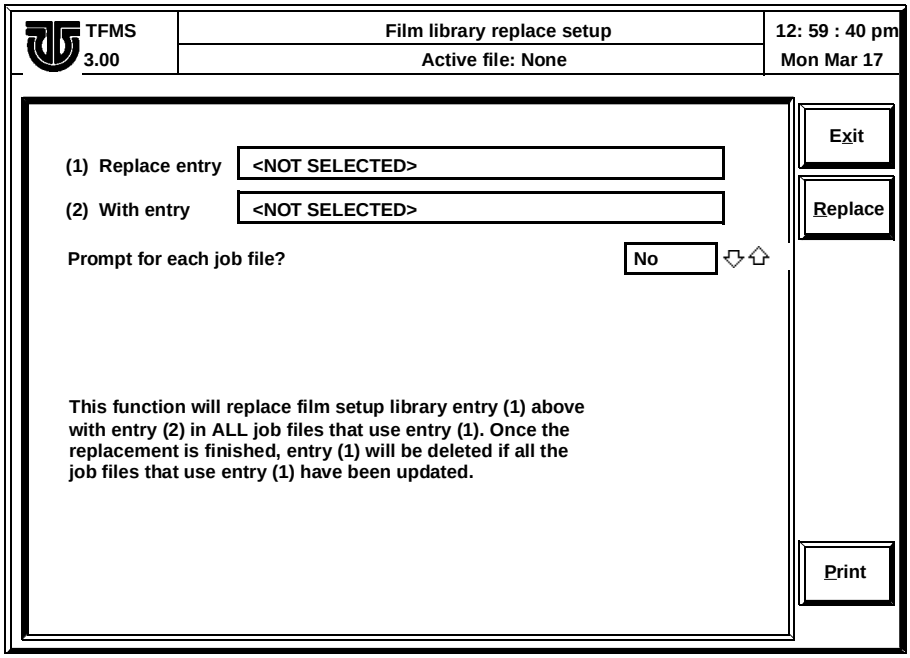
Figure 7.13 Film Library Maintenance window



Replace

When you select *Replace* in the *Setup*/*Library*/*Film* Function menu, the Film library replace setup window appears, as shown in Figure 7.14. In this window, you can replace a Film library entry with another Film library entry, and automatically update all job files using the old entry. After the replacement is completed, the system deletes the old entry from the library if it is no longer in use.

Figure 7.14 Film library replace setup


TFMS
3.00
Film library replace setup
Active file: None
12: 59 : 40 pm
Mon Mar 17
(1) Replace entry
<NOT SELECTED>
(2) With entry
<NOT SELECTED>
Prompt for each job file?
No
This function will replace film setup library entry (1) above with entry (2) in ALL job files that use entry (1). Once the replacement is finished, entry (1) will be deleted if all the job files that use entry (1) have been updated.
Exit
Replace
Print

(1) Replace entry:When you select this field, the Film library appears and you select a film entry to replace.

(2) With entry:When you select this field, the Film library appears and you select a film entry to use for replacement.

Prompt for each job file?When you select *Yes* in this field, the system displays a confirmation prompt for each affected job file before replacing a film entry. When you select *No*, this prompt does not appear.

***Replace* button:**When you select the *Replace* button, the system performs the Replace operation.

Purge

When you select *Purge* in the *Setup*/*Library*/*Film* Function menu, the Film library purge window appears, as shown in Figure 7.15. In this window, you can delete all film entries that are not used in any job file. This function only deletes unused entries that have automatically created default names (format: film, parameters, date, time). The system also deletes all duplicate film entries by opening each job

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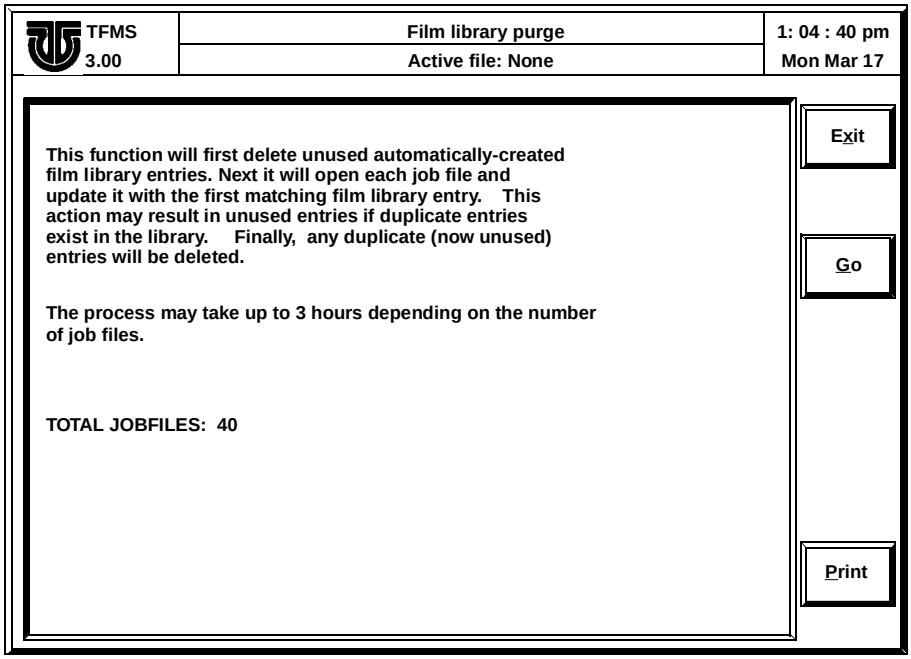
file and updating it with the first matching entry. It then deletes all the unused duplicates. Film library entries with personal names are not affected by the Purge operation. During this process, the system also converts any earlier version(s) of TFMS job files to TFMS 3.00 job files.

Figure 7.15 Film library purge window


TFMS
3.00
Film library purge
Active file: None
1: 04 : 40 pm
Mon Mar 17
This function will first delete unused automatically-created film library entries. Next it will open each job file and update it with the first matching film library entry. This action may result in unused entries if duplicate entries exist in the library. Finally, any duplicate (now unused) entries will be deleted.
The process may take up to 3 hours depending on the number of job files.
TOTAL JOBFILES: 40
Exit
Go
Print

***Go* button:** When you select the *Go* button, the system performs the purge operation.

Transfer

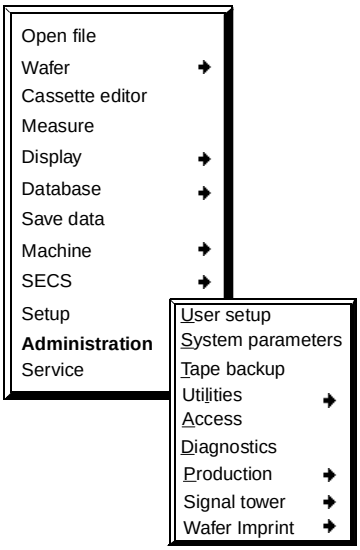
This option operates the same for the Film library as it does for the Custom template and Die template libraries (described earlier in this section).

7.3 ADMINISTRATION MENU

When you log into the system with a System Manager level User ID you can select *Administration* in the Main menu. When you select this option, the Administration menu appears, as shown in Figure 7.16.

Only the *Production* option is associated with individual job files. The *Signal tower* and *Wafer Imprint* options are only accessible on systems equipped with the necessary hardware.

Figure 7.16 Administration menu



7.3.1 User setup

When you select *Administration*/*User setup* , the User Setup window appears, as shown in the example in Figure 7.17. In this window, you can add, modify, or delete a User ID record or change the owner of a job file. A Function menu appears at the left side of the window. A User ID list displays the current User ID's and access levels, which appear in the order that they were entered into the system.

Add

When you select *Add* in the *Administration*/*User setup* Function menu, the Add window appears, as shown in Figure 7.18. In this window, you can add a user to the system.

User ID: When you select the *User ID* field, a keyboard window appears where you type the new User ID and then select the *Enter* button in the keyboard window's right margin. You can enter a maximum of 20 characters. After you enter the User ID, you return to the Add window and the new User ID appears in the *User ID* field.

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Figure 7.17 User setup window

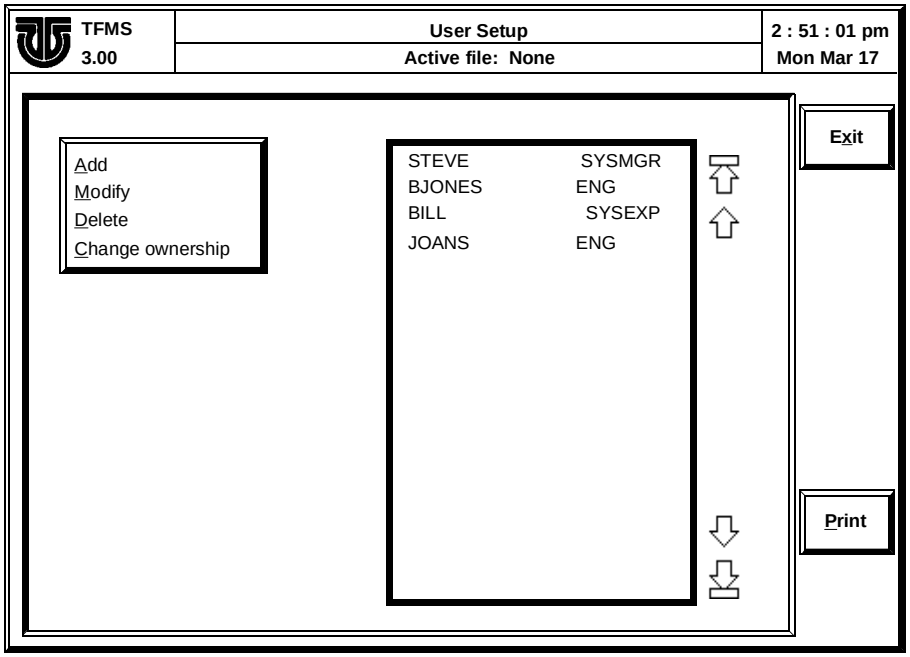
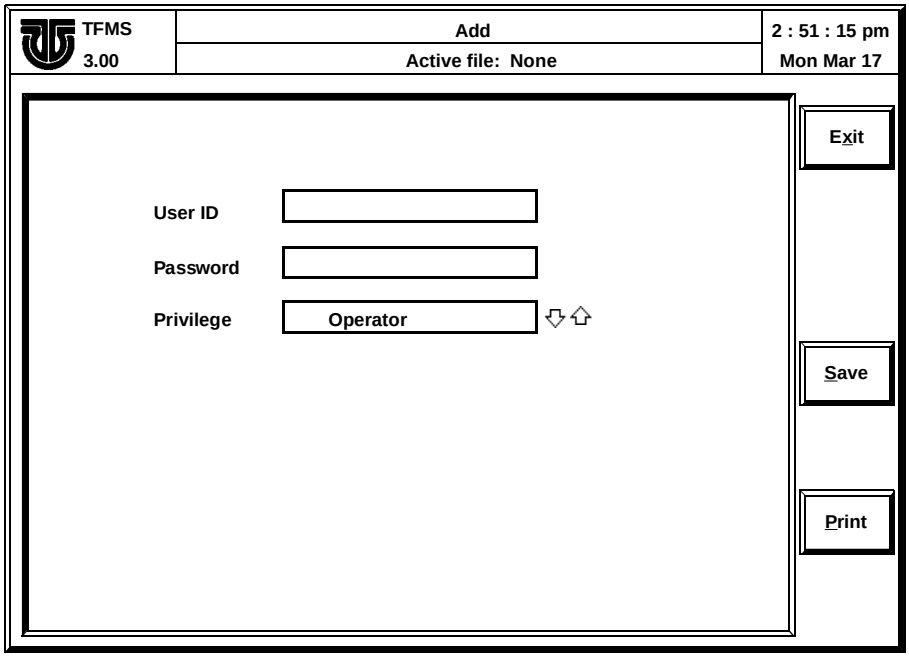


Figure 7.18 Add window



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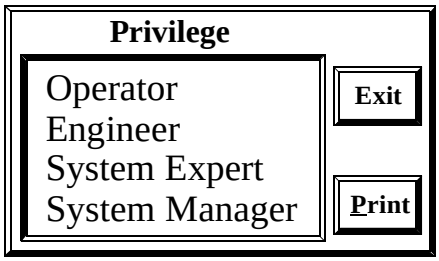
If you type a User ID that is already in the User ID list, a dialog box appears reminding you to enter a unique User ID.

Password: When you select the *Password* field, a keyboard window appears where you type a password associated with the new User ID and then select the *Enter* button in the keyboard window's right margin. When you type the password, each character appears as an asterisk in the keyboard window. The system asks you to enter the password twice to confirm the correct spelling. After you return to the Add window, the system fills the entire Password field with asterisks, regardless of the number of characters you entered. You can enter a maximum of ten characters.

Privilege: When you select the *Privilege* field, a pop-up menu appears, as shown in Figure 7.19, where you select an access privilege associated with the new User ID.

Figure 7.19 Privilege pop-up menu



After you select an access privilege for the new user, the Add window reappears with your selection displayed in the *Privilege* field.

Save button: You must select the *Save* button in the *Administration*/*User setup* /*Add* window to save the new User ID, password, and privilege. After you save your new entry, a blank record appears. If you select the *Save* button before entering a User ID, a dialog box appears with a message that says: *User ID must be filled*. You do not have to enter a password, but you must enter a User ID.

Exit button: When you select the Exit button, you return to the User Setup window. Any new User ID's entered in the Add window appear at the end of the User ID list.

You must select the *Exit* button to return to the User Setup window.

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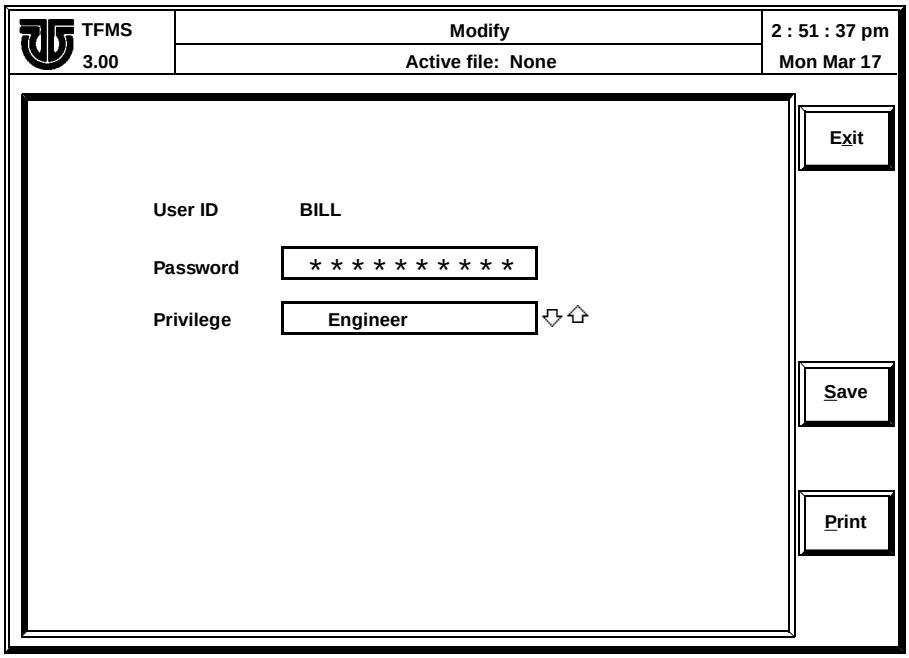
Modify

When you select a User ID, and then select *Modify* in the Function menu, the Modify window appears, as shown in Figure 7.20. In this window, you can change a password and/or access privilege associated with a specific User ID. If you do not select a User ID before you select *Modify*, a dialog box appears with a message that says: *Must select a User ID from the list box*. You select *Exit* in the dialog box to return to the User Setup window.

Figure 7.20 Modify window



User ID: Displays the selected User ID. You cannot select or modify the *User ID* field in the Modify window. You can change a User ID (name) by deleting the original record and adding a new one (see "Delete" on the next page).

Password, Privilege: Specify the password and access privilege for the selected User ID (displayed in the *User ID* field). You can modify a user's password and/or access privilege by following the steps described above for adding a user.

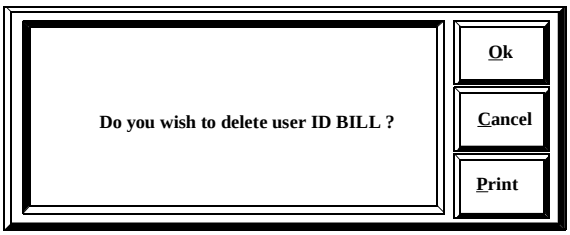
Save button: When you change a password or an access privilege, and then select the Save button in the Administration/User Setup/Modify window, the system saves your changes. No confirmation message appears, and the Modify window remains on the screen with your changes.

Exit button: You must select the *Exit* button to close the Modify window and return to the User Setup window. When you select the *Exit* button after making any unsaved changes in the Modify window, the changes are canceled.

Delete

Deletes a User ID from the system. When you select a User ID and then select *Delete* in the User Setup menu, a confirmation dialog box appears, as shown in the example in Figure 7.21. You can cancel the deletion by selecting the *Cancel* button in the dialog box. When you select *Ok* in the dialog box, the User Setup window reappears and the deleted User ID does not appear in the User ID list. If you do not select a User ID before you select *Delete*, a dialog box appears reminding you to do so.

Figure 7.21 Delete User ID dialog box



Change ownership

When you select *Change ownership* in the *Administration*/*User setup* Function menu, the Change Ownership window appears, as shown in Figure 7.22. In this window, you can change the owner of a directory, sub-directory, job file, or job file chain. You can also re-enter the owner if a User ID is accidentally deleted. The example in Figure 7.22 shows this window when no job file or job file chain is open (the Active file is None) and the first name in the User ID list is STEVE.

Current owner: Displays the current owner of the entry in the *Job file path* or *Job chain name* field(described later). If a job file is not open and you did not enter a job file path or job chain name, *No owner* appears in this field.

Job file path: Specifies the job file path for the directory, sub-directory, or job file that requires new ownership. When a job file is open and you select *Administration*/*User setup* /*Change Ownership*, the active job file's path appears in the *Job file path* field. If a job file is not open, *No active job file* appears in this field. To change the owner of a job file that is not open, you select this field to

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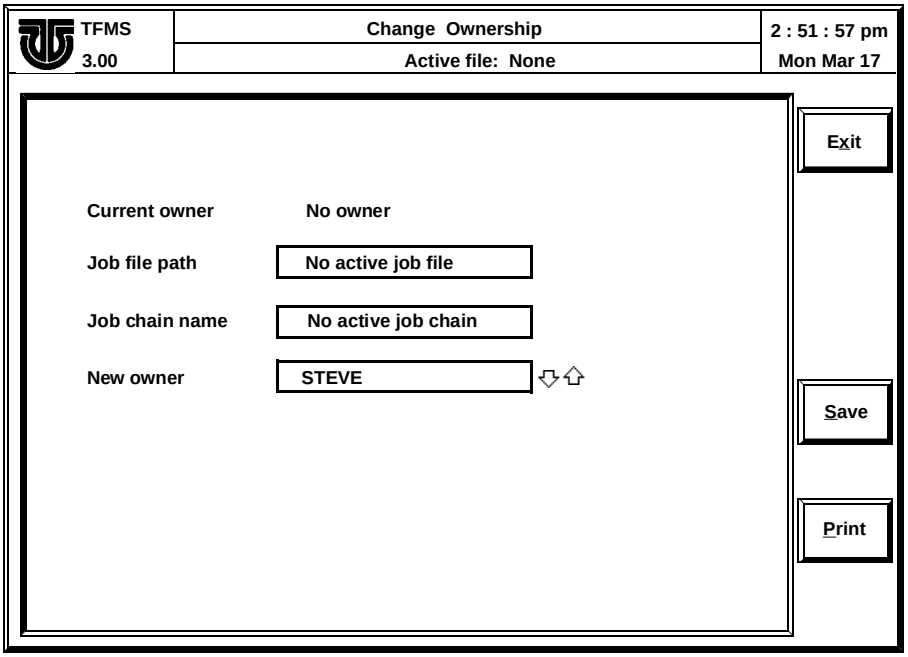
Figure 7.22 Change Ownership window



open the Select window, shown in the example in Figure 7.23. This window looks similar to the Open file window and you can select the desired job file path that requires a new owner. An *Enter* button appears in the right margin.

Enter button: After selecting the desired job file path, and then the *Enter* button, the Change Ownership window reappears with your selection displayed in the *Job file path* field, as shown in Figure 7.24 for directory level ownership.

For directory level ownership, the name of the directory appears with an * for the sub-directory(s) and an * for the job file(s). For sub-directory level ownership, the names of the directory and sub-directory appear and an * appears for the job file(s). For job file level ownership, the complete job file path appears. For example:

```
AMS\*\*          =   directory level ownership
AMS\DAILY\*      =   sub-directory ownership
AMS\DAILY\TEST   =   job file level ownership
```

Job chain name : Specifies the name of the job file chain that requires new ownership. When a job file chain is open and you select *Administration*/*User setup*

Figure 7.23 Select window

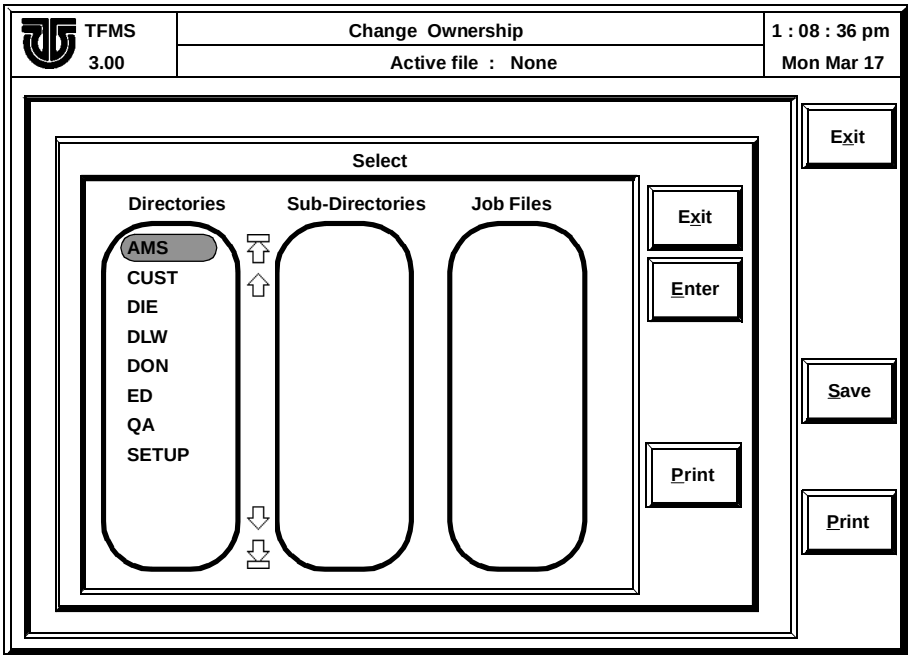
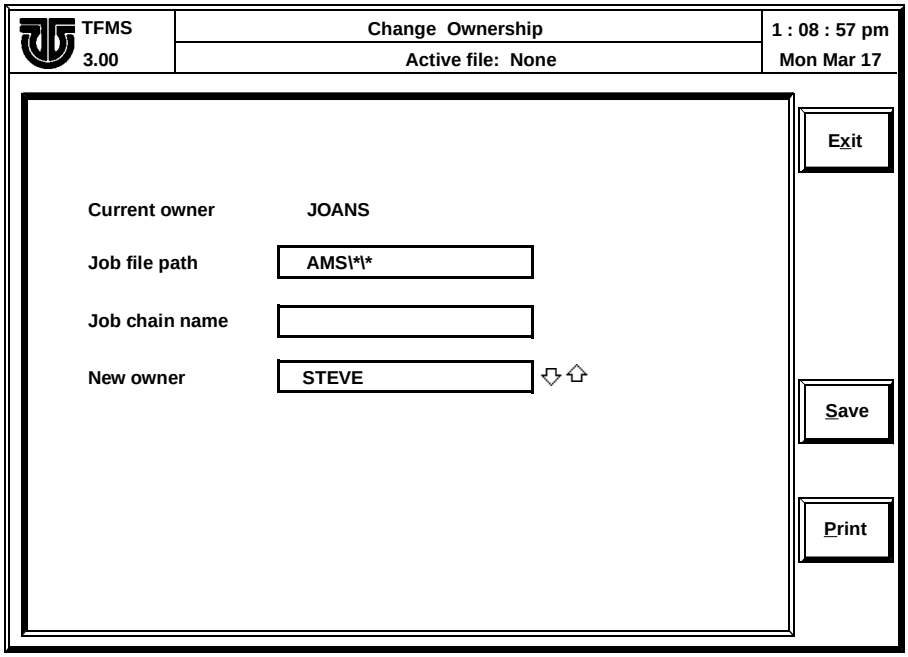


Figure 7.24 Change ownership window (after selecting a new owner for a job file path)



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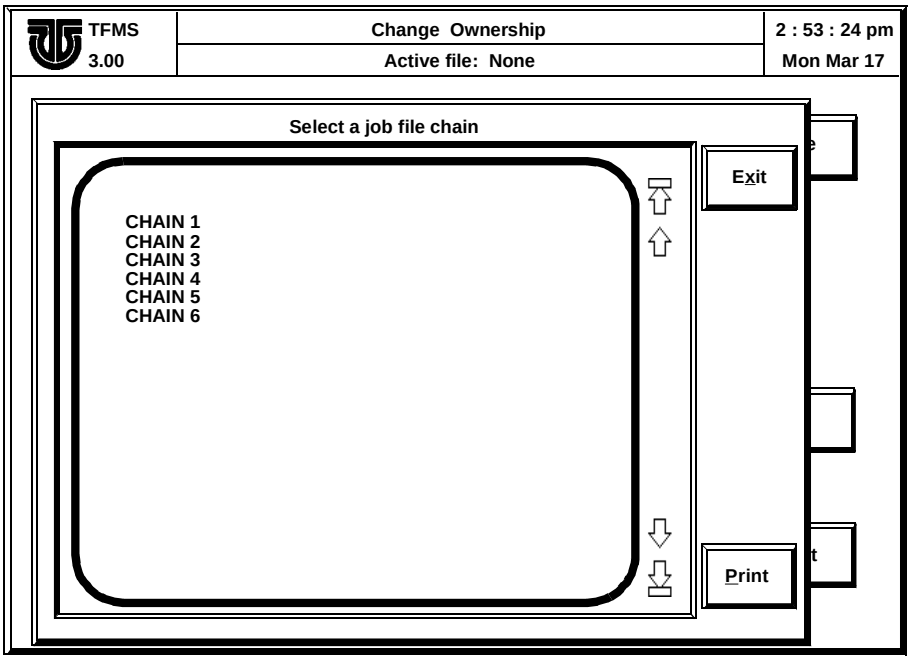
/ *Change Ownership* , the *Job chain name* field displays the active job file chain. If a job file chain is not open, *No active job chain* appears in this field, as shown in the example in Figure 7.22. To change the owner of a job file chain that is not open, you select this field to open the Select a job file chain window, shown in the example in Figure 7.25. In this window you can select the desired job file chain that requires a new owner.

Figure 7.25 Select a job file chain window

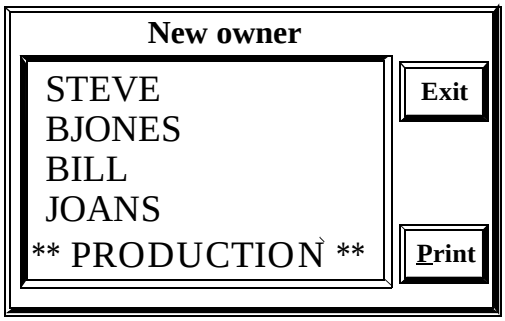


When you select a job file chain, the Change Ownership window re-appears with the selected job file chain and the current owner displayed in their corresponding fields.

New owner:Specifies the new owner for the selected job file or job file chain. When you select *Administration*/*User setup* /*Change Ownership*, this field displays the first entry in the User ID list. When you select this field, a list of current User ID's and a ** Production ** ID appears in a pop-up menu or in a window with scrolling arrows, depending on the number of User ID's. If there are 13 or less User ID's, the New owner pop-up menu appears, as shown in the example in Figure 7.26. If there are 14 or more User ID's, the New owner window appears, which looks similar to Figure 7.25, and you can use the scrolling arrows

to display any additional entries. After you select the new owner's User ID, your selection appears in the *New owner* field in the Change Ownership window.

Figure 7.26 New owner window



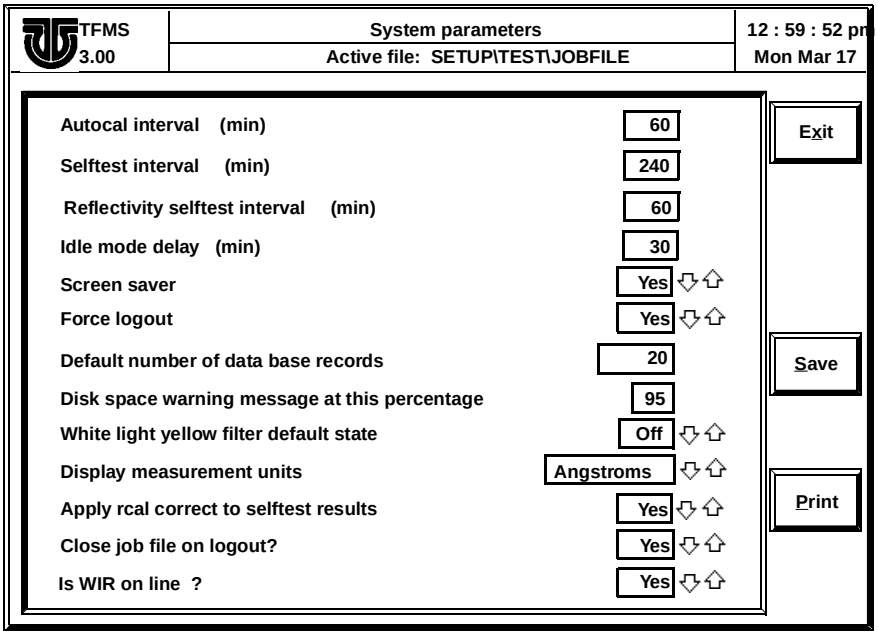
Production: This ownership option allows you to modify specific job file parameters and limit user accessibility each time the selected job file is opened, as described later in this section.

Save button: Saves the new owner for the selected job file path or job file chain without displaying a confirmation message. If you select a job file that is owned by Therma-Wave, a dialog box appears informing you that you do not have the privilege to change the owner.

7.3.2 System parameters

When you select *System parameters* in the Administration menu, the System parameters window appears, as shown in Figure 7.27. In this window, you can edit the time intervals between the tests automatically run by the system. Therma-Wave sets these time intervals to optimize system performance. Therefore, you should exercise extreme caution before editing these values. You can also set up the idle mode delay, screen saver, default number of data base records, disk warning message, white light filter default state, closing of job files on logouts, ellipsometer calibration correction following a system test, force a logout after the system is idle for the specified time, and indicate whether a Wafer Imprint Reader is online.

Figure 7.27 System parameters window


TFMS
3.00
System parameters
Active file: SETUP\TEST\JOBFILE
12 : 59 : 52 pm
Mon Mar 17
Autocal interval (min) 60
Selftest interval (min) 240
Reflectivity selftest interval (min) 60
Idle mode delay (min) 30
Screen saver Yes
Force logout Yes
Default number of data base records 20
Disk space warning message at this percentage 95
White light yellow filter default state Off
Display measurement units Angstroms
Apply rcal correct to selftest results Yes
Close job file on logout? Yes
Is WIR on line ? Yes
Exit
Save
Print

Autocal interval (min)

Specifies the interval between autocalibrations. During an autocalibration, the system performs measurements on an internal Si reference sample to correct for signal level drift. This test takes about 30 seconds for a standard 486-equipped system.

Selftest interval (min)

Specifies the interval between selftests. During a selftest, the system performs several other internal tests, including a laser wavelength check and a spectrometer reference measurement, and performs an autocalibration. This test takes about 2 minutes, 45 seconds with a standard 486-equipped system.

Reflectivity selftest interval (min)

Specifies the interval between reflectivity selftests on systems with array spectrometers. The reflectivity calibration uses an independent timer.

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Idle mode delay (min)

Specifies the interval of inactivity that activates idle mode. During idle mode, the system continues to perform autocalibrations and selftests at the specified intervals. This utilizes the time when the system is idle between user sessions. The system only activates idle mode if the Main Menu window appears on the screen.

In this field, you can enter the idle mode delay in minutes. You can disable the idle mode by entering a value of 0.

Screen saver

Specifies whether or not to activate the screen saver during idle mode. You select either *On* or *Off* to activate or de-activate the screen saver. The screen saver displays a series of multi-color Therma-Wave logos. This prevents video "burn-in" and preserves the life of the TFMS monitor. You can turn off the screen saver and return to the Main Menu window by pointing the light pen at any location on the screen where logos appear. If the screen saver is not activated for idle mode, the screen is black during this period.

Force logout

Specifies whether any Engineer or higher level user is automatically logged out after the system is idle for the time specified in the *Idle mode delay (min)* field. To set up this function, the screen saver must also be enabled.

Default number of data base records

Specifies the default number of records that appear in database display windows (ending with the last record).

Disk space warning message at this percentage

Specifies the percentage of hard disk space that must be filled before the disk warning message appears.

White light yellow filter default state

Specifies whether the white light filter is on or off as a default. If you change this parameter, either here or in the Machine menu, the Opti-Probe performs a system test before the next measurement. When you turn on the system, the selected default state is set automatically.

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Display measurement units

Specifies whether to display thickness measurement units in Angstroms or Nanometers.

Apply rcal correct to selftest results? (ellipsometer models only)

Specifies whether the system automatically corrects the ellipsometer calibration following a system test. This is useful when there is thickness variation in reference chips.

Close job file on logout?

Specifies whether the system closes any active job file when a user logs out.

Is WIR on line ?

Specifies whether a Wafer Imprint Reader is installed.

7.3.3 Tape backup

You can back up your job files, including recipes, data, and pattern recognition files, by performing a tape backup operation. Before you select *Tape backup*, make sure you have a formatted blank tape(s) available. For models without a VP, back up the D: drive. For models with a VP, back up the D: and E: drives. The D: drive contains the job file recipes and data and the E: drive contains the pattern recognition model files for systems with a VP installed. You can perform a total, selective (tagged files), or incremental (modified files) backup. This tutorial shows you how to perform a total backup.

1. Select *Tape backup* in the Administration menu.

   If a job file is open the system closes it, freeing up additional memory for the tape backup utility program.

   The tape backup utility program boots up.

2. Insert a blank, formatted tape in the tape drive.

3. Open the keyboard cover, located at the front of the Opti-Probe, below the video monitors.

4. Confirm or enter the correct date and time, and press the <ENTER> key after each entry.

   The Tape backup utility program's Main menu appears.

5. Press the <F1> key to select *Backup to Tape*.

   The Backup menu appears.

6. Press the <F2> key to select a *Total backup*.

   The latest tape backup software allows you to perform a total backup without pausing between each partition. If your system has the new software, you can proceed to step 8.

7. Type the letter of the hard disk partition that you'd like to back up.

   The system checks the number of files and bytes in the partition and verifies that the tape has enough space to copy all the files. If the tape has enough space, a message appears requesting the volume title.

8. Type the volume title.

   If you plan to include more than one backup on the same tape, include the date and drive (partition name) in the volume title.

9. Select a compression option.

   You select *File compression* to save space on the tape. You select *No file compression* to save time.

10. Disable the password protection.

11. Press the <F1> key to begin the backup operation.

    As the backup proceeds, a status screen appears which displays the following information:

    - File currently being processed
    - Total bytes written on the tape

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- Number of bytes remaining
- Number of files remaining
- Estimated fraction of backup complete
- Estimated time remaining
- Operation status (e.g., tape drive working, saving files, comparing files, operation successful etc.)

If the backup operation fills one tape and requires another, a message appears asking you to insert another tape. If the new tape is not formatted (or is not empty), the program formats it automatically.

The program takes up to twice its estimated time to perform a backup. It takes 1 hour to format a tape.

When the backup is complete, the operation status area displays one of the following messages:

Operation successful

Operation complete with errors (see error log)

12. Press the <F10> key to return to the Backup menu.

13. Repeat steps 6-12 for any other partition(s) you'd like to back up.

    If your system has the upgraded tape backup software, all partitions are now backed up and you can skip to step 14.

    If your system has a VP installed, back up both the D: and E: partitions for maximum security of your job files.

14. Press the <F10> key twice to quit the tape backup utility program from the Backup menu.

A dark screen appears with a message that says:

Closing tape drive...

Finished...Press RETURN *to continue*:

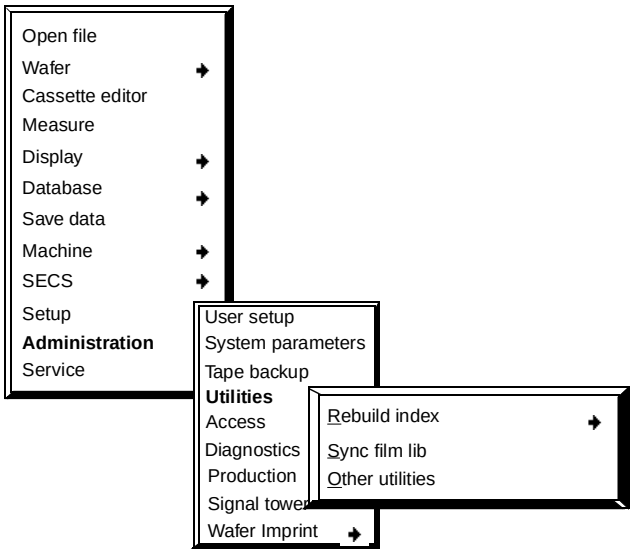
15. Remove the tape from the tape drive and press the <ENTER> key.

The system returns to the Administration menu.

7.3.4 Utilities

When you select *Administration*/*Utilities*, the Utilities menu appears with three options, as shown in Figure 7.28. You select these options if the Film, Die template, Custom template or Job chain library is corrupted and requires re-indexing, or if the film library requires synchronization, i.e., if erroneous names appear, expected names do not appear, etc.

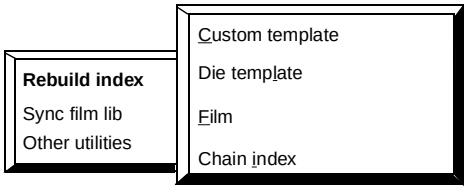
Figure 7.28 Utilities menu



ebuild index

When you select *Rebuild index* in the Utilities menu, the Rebuild index menu appears with three options, as shown in Figure 7.29.

Figure 7.29 Rebuild index menu



Custom template: When you select *Custom template*, the system rebuilds the Custom template library index.

Die template: When you select *Die template*, the system rebuilds the Die template library index.

Film: When you select *Film*, the system rebuilds the Film library index.

Chain index: When you select *Rebuild chain index*, the system rebuilds the Job chain library index.

Sync film lib

When you select *Sync film lib*, the system synchronizes (reconnects) job files with specific films if there are problems with the film library, e.g., name changes on user-defined films or job files etc. To complete this operation, an hour or more may be required (for a large number of job files and film entries).

Other utilities

When you select this option in the Utilities menu, the Other Utilities window appears with four options, as shown in Figure 7.30. When you select one of these options, and then select the *Go* button, the System runs the corresponding utility.

7.3.5 Access

When you select *Access* in the Administration menu, the Access window appears, as shown in Figure 7.31. In this window, you can allow or disallow Engineer level users to save changes in another Engineer's job file. In addition, you can grant or deny Engineer level users access to the *Setup*/*Recipe* /*Film* setups and the *Setup*/*Library*/*Film* functions.

Figure 7.30 Other Utilities window

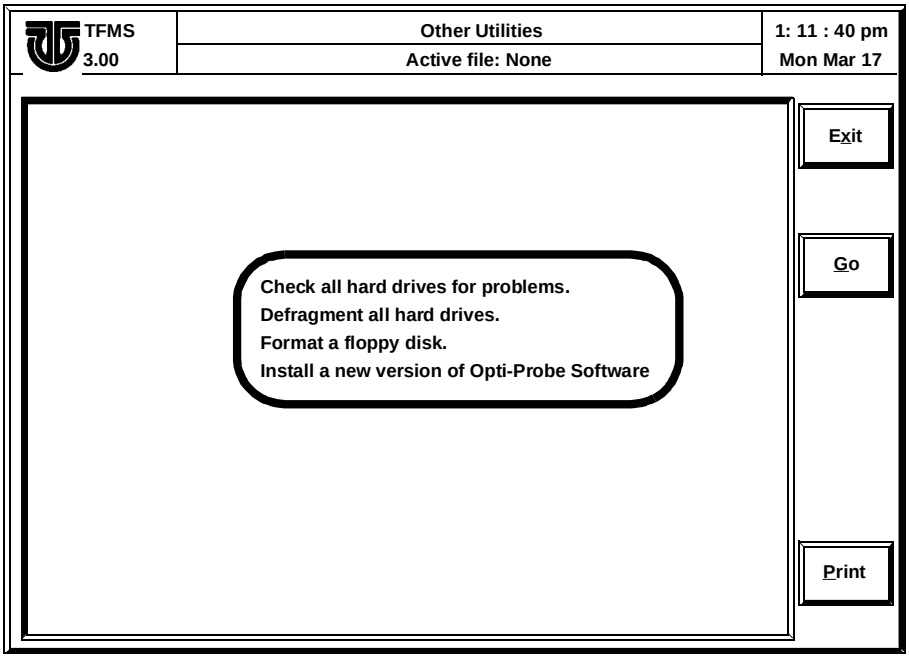
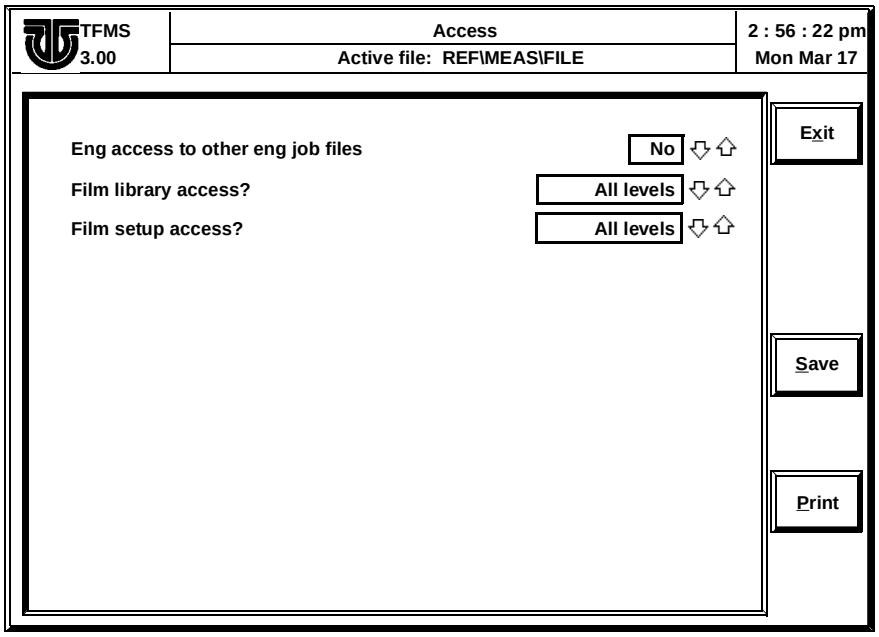


Figure 7.31 Access window



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Eng access to other Eng job files

Specifies whether an Engineer level user can change another Engineer's job file.

Film library access

Specifies whether an Engineer level user can access all the Film library maintenance functions. If you select *All levels*, Engineers, System Experts, and System Managers can access these functions. If you select *Not Engineer*, only System Experts and System Managers can access these functions. This parameter sets the access level for all engineers (including their own job files) and is job file independent.

Film setup access

Specifies whether an Engineer level user can access the film setup parameters. If you select *All levels*, Engineers, System Experts, and System Managers can access the film setup parameters. If you select *Not Engineer*, only System Experts and System Managers can access these parameters. This parameter sets the access level for all engineers (including their own job files) and is job file independent.

7.3.6 Diagnostics

When you select *Administration*/*Diagnostics*, the Diagnostics window appears, as shown in Figure 7.32. In this window, you can set up several diagnostic functions.

Number of mask errors logged

If you specify the logging of mask alignment vision errors (below), this field displays the number of such errors.

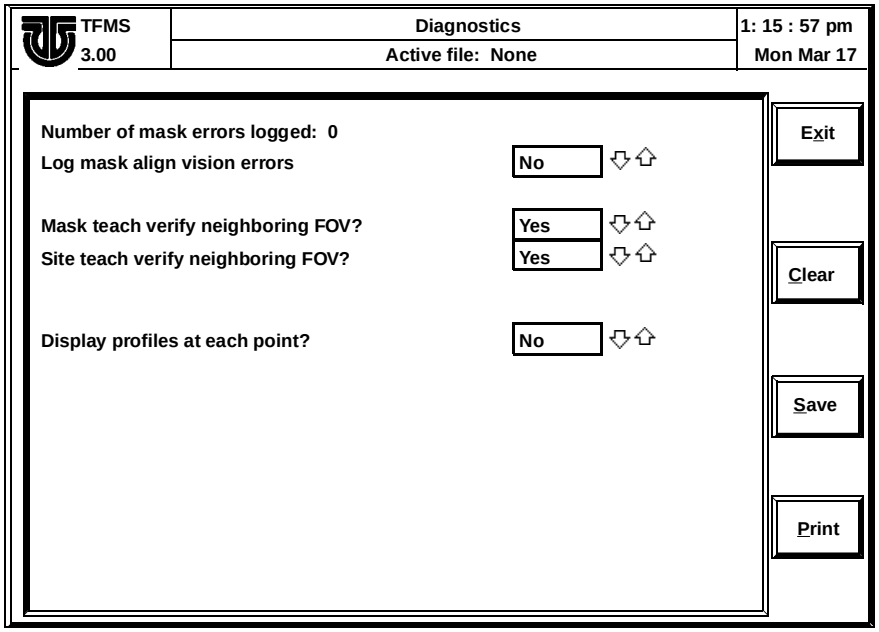
Log mask align vision errors?

In this field, you can specify whether to log the number of mask alignment search errors.

Mask teach/Site teach verify neighboring FOV?

In this field, you can set up the mask teach and/or site teach functions to search the neighboring fields of view (FOV) for any pattern that is similar to the site or mask model. This can eliminate ambiguity and verifies whether the site or mask model is adequate.

Figure 7.32 Diagnostics window



Display profiles at each point?

In this field, you can set up the system to automatically display the A & B profiles and spectrum (if selected) after each measured point during the measurement process. This function is similar to using the *Show* button after a single point measurement, except in this case there is no *Show* button and it is applicable for all measurement types.

7.3.7 Production

When you select *Administration*/*Production*, two options appear in the Production menu, *Params* and *Setup access*, as shown in Figure 7.33. With these options, you can configure any job file that has a Production ownership.

Params

When you select this option, the Production Setup window appears, as shown in Figure 7.34. This window allows you to override (preempt) the current *Yes* or *No* entries for the displayed parameters in Production job files. You can select from

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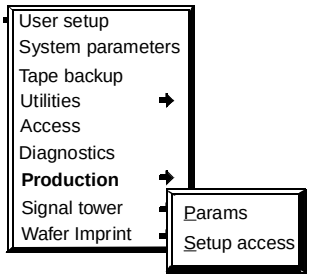
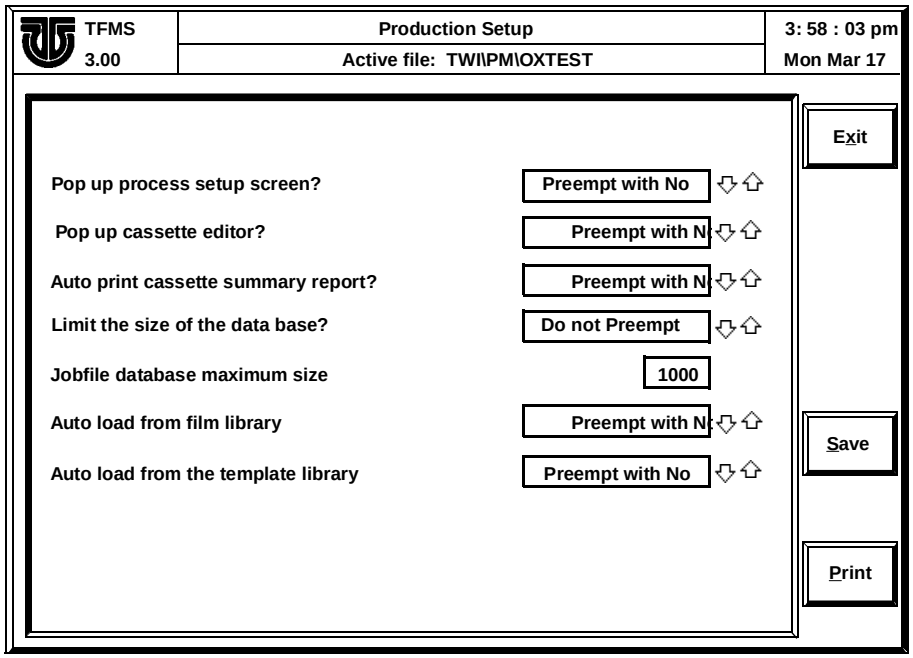
Figure 7.33 Production menu



three options, *Preempt with No*, *Preempt with Yes*, and *Do not Preempt.* You can also override the current maximum database size.

Figure 7.34 Production Setup window

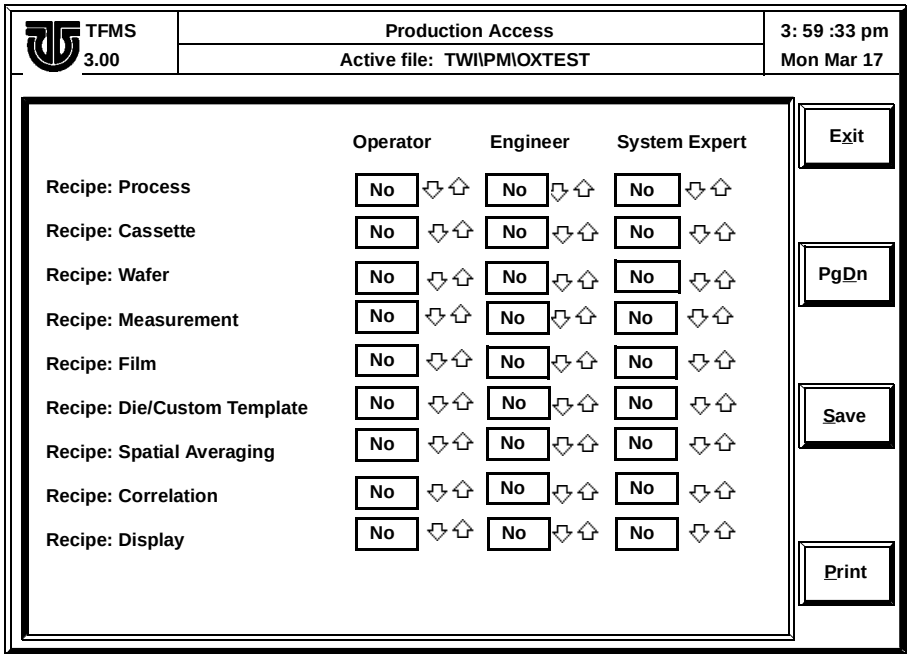


Setup access

When you select this option, the Production Access window appears, as shown in Figure 7.35. In this window, you can grant or deny accessibility to the selected Production job file's displayed recipe setups, libraries, and SPC database, according to user level. This also includes the Operator level. Users with access to any of the specified recipe setups, can only save changes to these setups. For

production job files, users do not have access to the *Setup*/*File*/*Save* option, so global changes are not possible.

Figure 7.35 Production Access window (Setup/Recipe options)



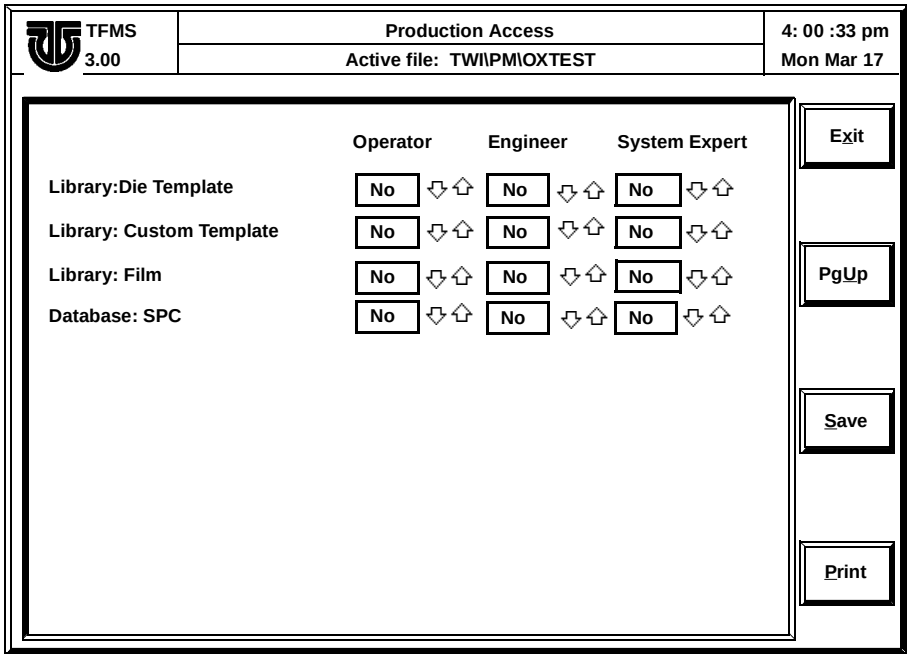
PgDn button: When you select this button in the Production Access window, the Library and Database options appear, as shown in Figure 7.36.

7.3.8 Signal tower (Signal tower equipped systems only)

The signal tower is a visual indicator of the Opti-Probe's current status. After you configure the required parameters, the Opti-Probe controls the signal tower lights as it proceeds from one machine state to another. In addition, on SECS equipped systems (in online mode), the remote host uses the signal tower to communicate with the operator.

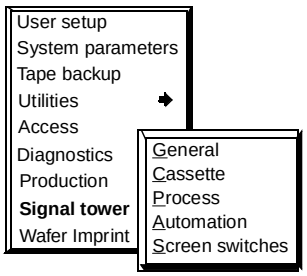
The signal tower lights appear in four colors: green, amber, red, and blue. When the system is installed, the lights are all off. You set up different color combinations and conditions (on, off, flashing) for the desired events – to show the current status of the system or to signify a transitional state.

Figure 7.36 Production Access window (Library and Database options)



When you select *Signal tower* on a properly equipped system, the Signal tower menu appears, as shown in Figure 7.37. The options in this menu allow you to specify the light output for different categories of system conditions.

Figure 7.37 Signal tower menu



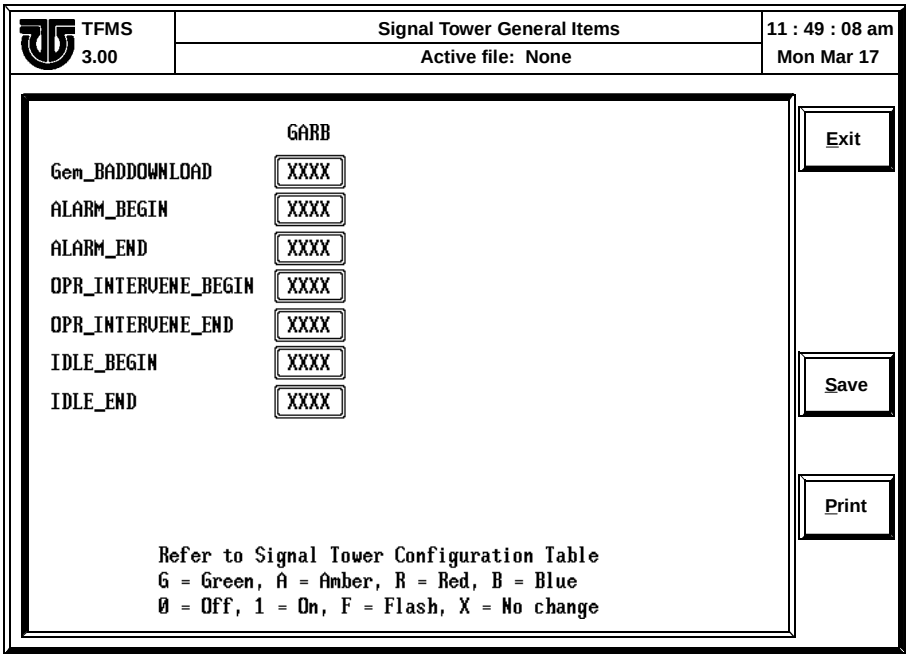
General

When you select this option, the Signal Tower General Items window appears, as shown in Figure 7.38. In this window, you can select the light outputs for each of the listed general machine events. Each event is a transition from one machine state to another.

At the bottom of the window the respective entry code characters are shown for each light's output and a message tells you to refer to the Signal tower configuration table. You should use the table and the signal tower specifications provided by your organization to configure the light output for each machine event. The table should indicate your organization's name for each of the listed machine events, so you can translate Therma-Wave's name and replace it with your own entries. An example configuration table appears in Figure 7.39. Appendix D provides you with a blank Signal tower configuration table, with definitions for TWI machine events. You should copy this blank table and enter all the applicable information for your organization. For SECS collection events, refer to your "Opti-Probe GEM SECS User Manual," Section 15.1.

A light selection field appears next to each of the listed machine states. *GARB* appears above the fields, representing the Signal tower's four colors. The default entry, *XXXX* (no change) specifies that the light output for the corresponding machine event does not change from the existing output.When you select any of these fields, a keyboard window appears where you can enter the desired light output using your configuration table and the entry code characters at the bottom of the window. When you replace one or more X's with any of the entry code characters displayed at the bottom of the window, the respective machine event's current light output varies accordingly.

Figure 7.38 Signal Tower General Items window



Signal tower configuration table

Figure 7.39 Example Signal Tower Configuration Table

Line Num	Category	Therma-Wave Event Name	Owner Event Name	Outputs (0 = OFF, 1 = ON, F = FLASH, X = NO CHANGE) G	A	R	B	Comments
	General Events	GemBADDOWNLOAD (CEID 7)	WAIT BEGIN	X	X	1	X	
		ALARM_BEGIN	WAIT BEGIN	X	X	1	X	
		ALARM_END	WAIT END	X	X	O	X	
		OPR_INTERVENE_BEGIN	WAIT BEGIN	X	X	1	X	
		OPR_INTERVENE_END	WAIT END	X	X	O	X	
		IDLE_BEGIN	—	X	X	X	X	
		IDLE_END	—	X	X	X	X	

Cassette

When you select this option, the Signal Tower Cassette and Port Items window appears, as shown in Figure 7.40. In this window, you can select the light tower outputs for each of the listed machine events.

Process

When you select this option, the Signal Tower Process Items window appears, as shown in Figure 7.41. In this window, you can select the light tower outputs for each of the listed machine events.

Automation

When you select this option, the Signal Tower Automation Items window appears, as shown in Figure 7.42. In this window, you can select the light tower outputs for each of the listed machine events.

Screen Switches

When you select this option, the Signal Tower Screen Switches window appears, as shown in Figure 7.43. In this window, you can select the Signal tower outputs

Figure 7.40 Signal Tower Cassette and Port Items window

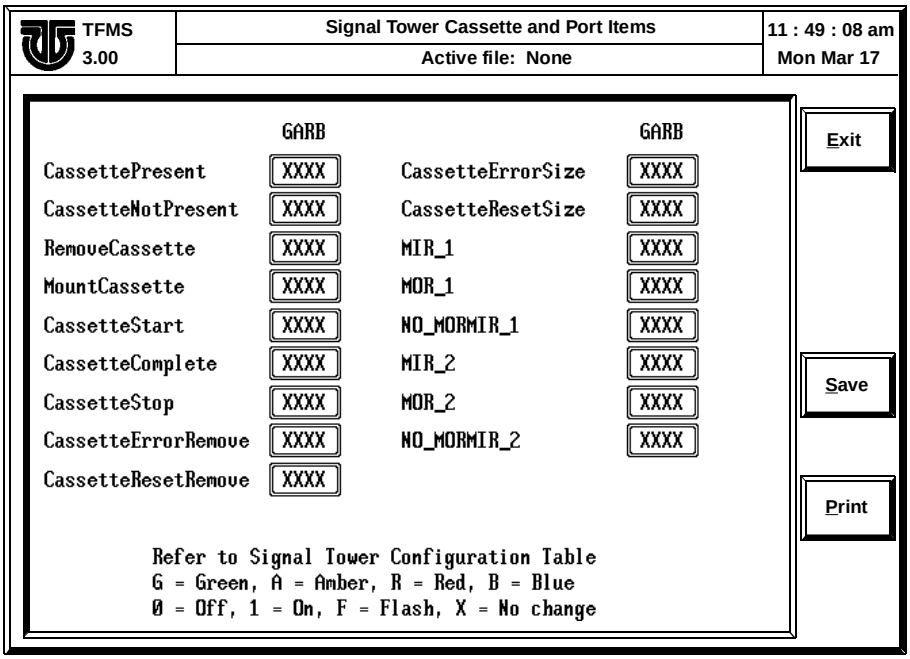


Figure 7.41 Signal Tower Process Items window

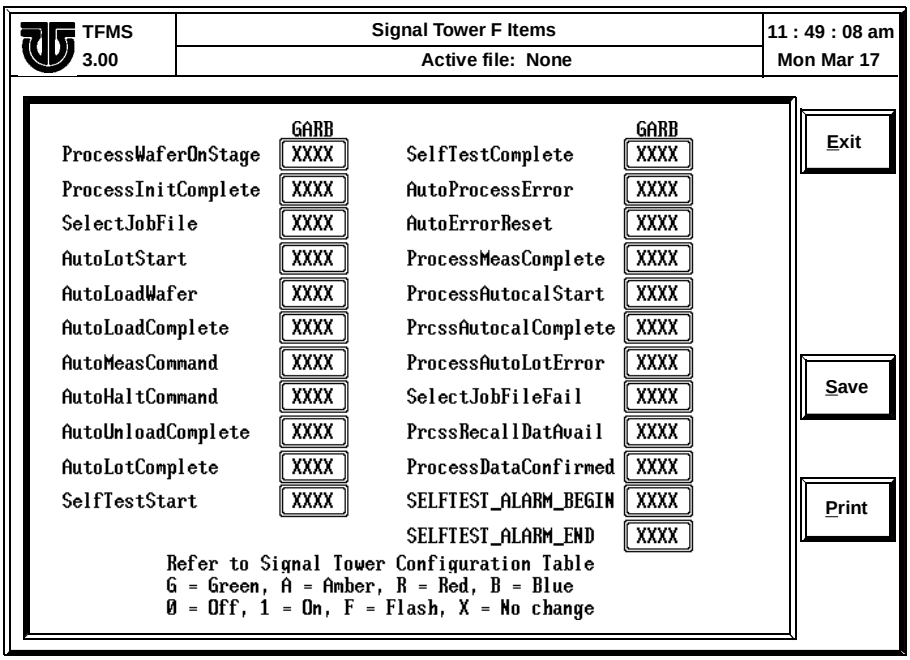


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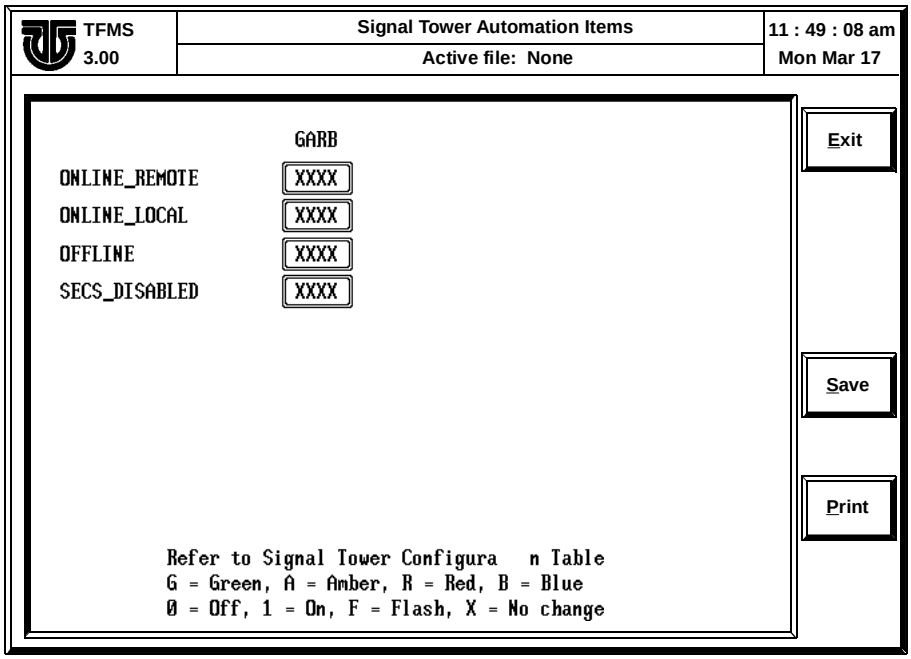
Figure 7.42 Signal Tower Automation Items window



for each of the listed machine events, and control these outputs manually with two screen switches, *Down* and *Available*. For SECS equipped systems, you can also specify either Host control of the Signal tower or both Host and Equipment control.

Down/Available switches: Enable or disable the light output for their respective machine events. You toggle the switches *On* or *Off* to specify the beginning of system downtime, end of system downtime, beginning of system availability, or end of system availability.

Down/On = Down _Begin, Down/Off = Down _End,

Available/On =Available _Begin, Available/Off = Available_ End.

Control of signal tower: When you select this field, two SECS-related options appear that specify whether the signal tower can be controlled only by the SECS host or by both the SECS host and the local system, as shown in Figure 7.44. For more information, see your "SECS User Manual. "

Figure 7.43 Signal Tower Screen Switches window

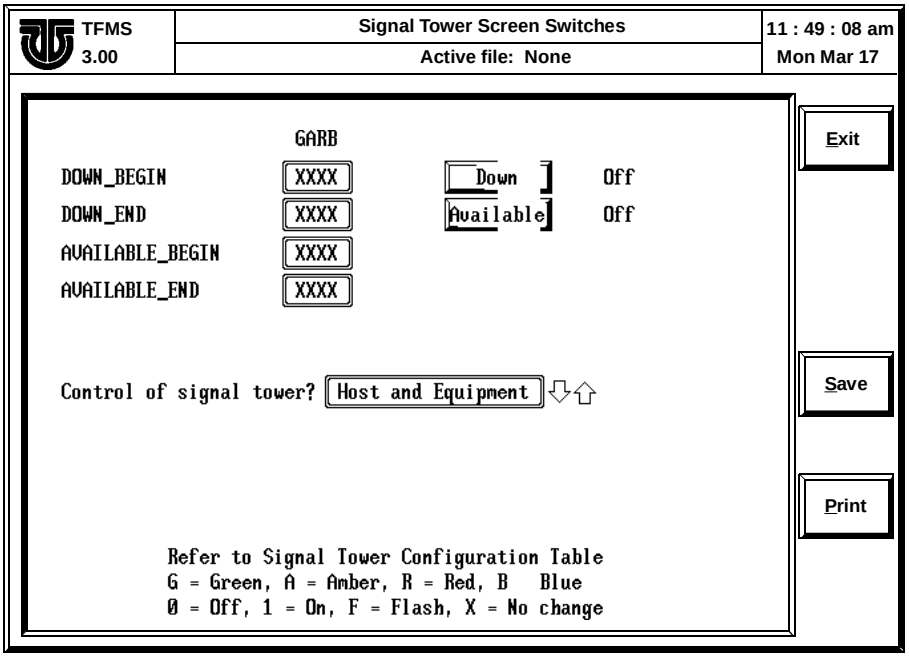


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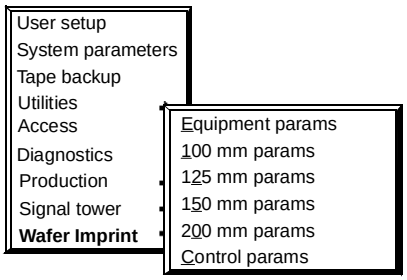
Figure 7.44 Signal tower control pop-up menu

7.3.9 Wafer Imprint (WIR systems only)

When you select this option on a WIR equipped system, the Wafer imprint menu appears, as shown in Figure 7.45.

Figure 7.45 Wafer imprint menu

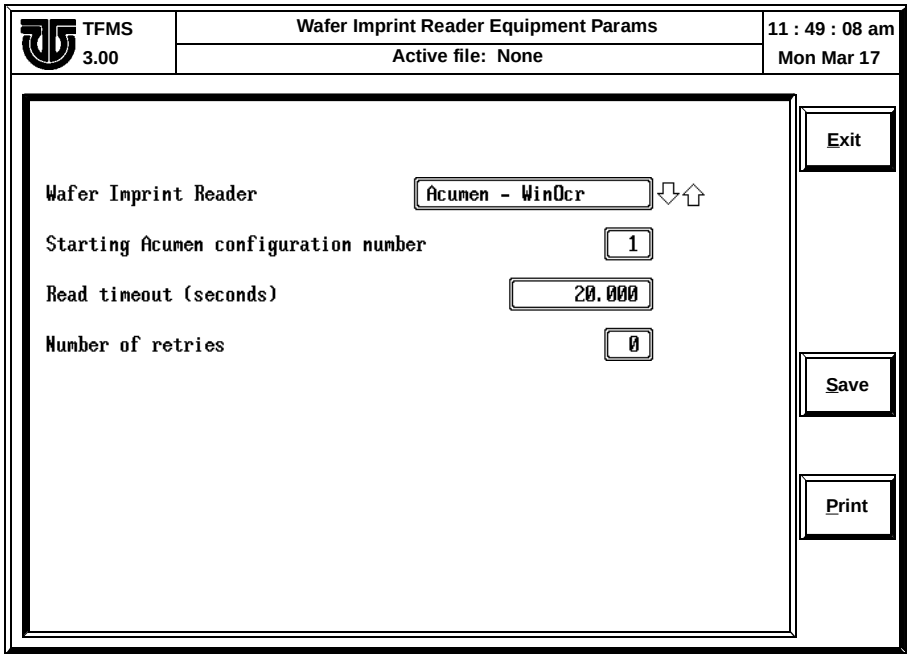


Equipment params

When you select this option, the Wafer Imprint Reader Equipment Parameters window appears, as shown in the example in Figure 7.46.

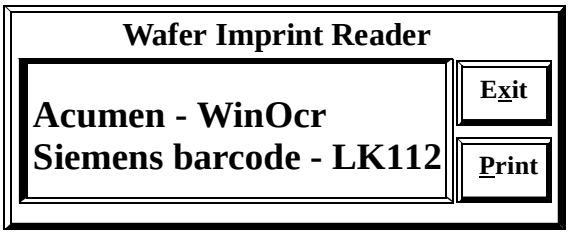
Wafer Imprint Reader: This specifies the type of WIR reader installed on your system. Currently, the system supports two WIR's, the *Acumen - WinOcr* and the

Figure 7.46 WIR Equipment Parameters window



Siemens barcode - LK112.. These options appear in a pop-up menu, as shown in Figure 7.47.

Figure 7.47 Wafer Imprint Reader pop-up menu



Starting Acumen configuration number (Acumen systems only): Specifies the starting configuration number for an Acumen OCR.

Read timeout (seconds): Specifies how long (in seconds) the system tries to read a wafer imprint.

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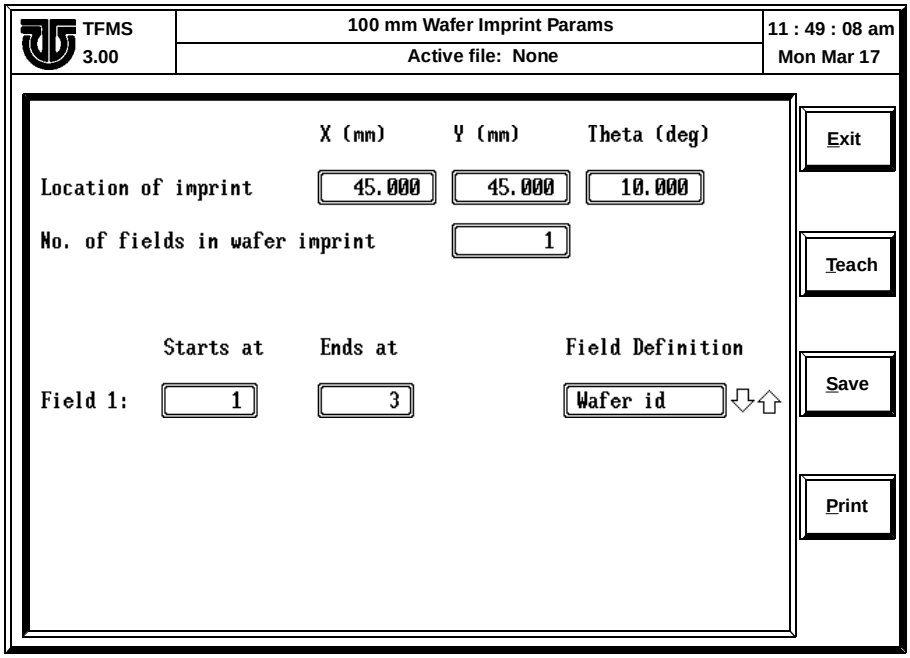
Number of retries: Specifies how many wafer imprint reads the system attempts after an initial failure.

100 mm, 125 mm, 150 mm, 200 mm/params

When you select any of these wafer size options in the *Administration*/*Wafer Imprint* menu, the corresponding Wafer Imprint Parameters window appears, as shown in Figure 7.48 for a 100 mm wafer. A *Teach* button appears in the right margin. In this window, you teach the system the location of the wafer imprint, and identify and define each of its fields.

Figure 7.48 Wafer Imprint Parameters window

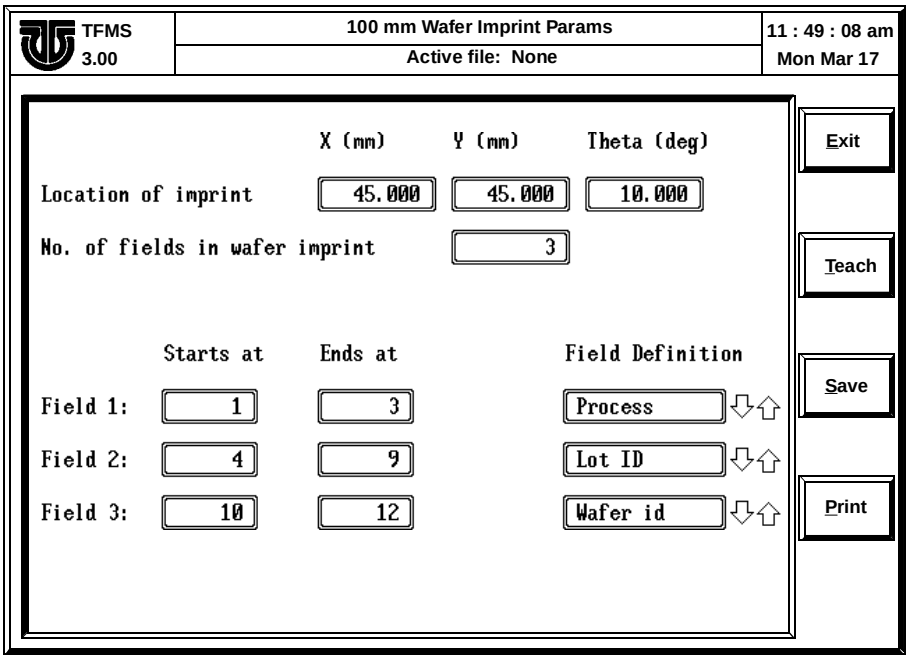


Location of imprint: Specifies the approximate X, Y, and Theta stage locations where the wafer imprint is located.

No. of fields in wafer imprint: Specifies the number of fields within the wafer imprint (maximum of 5). When you specify more than one field, the window

re-appears, displaying these fields in their numerical sequence. The example in Figure 7.49 specifies three fields and shows some typical entries.

Figure 7.49 Wafer Imprint Parameters window (after specifying three wafer imprint fields and defining each field)



Field 1, 2, 3 etc./Starts at, Ends at: Specify the numerical starting point and ending point of each wafer imprint field, relative to the number of characters in the entire wafer imprint. This shows the system how to identify each field. A field's starting position cannot exceed its ending position and must exceed the previous field's ending position. If you enter incorrect numbers, a reminder message appears.

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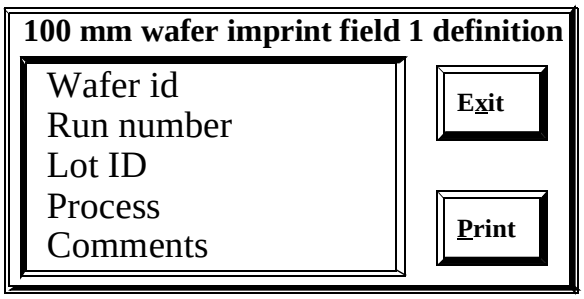
Field Definition: Specifies the meaning of each wafer imprint field. You can select from the options displayed in the pop-up menu shown in Figure 7.50.

Figure 7.50 Wafer Imprint field definition pop-up menu



Teach button: When you select this button in a Wafer Imprint Parameters window, a Stage locator window appears, displaying your X, Y, and Theta coordinates for the wafer imprint location. In this window, you can fine tune the location of the wafer imprint.

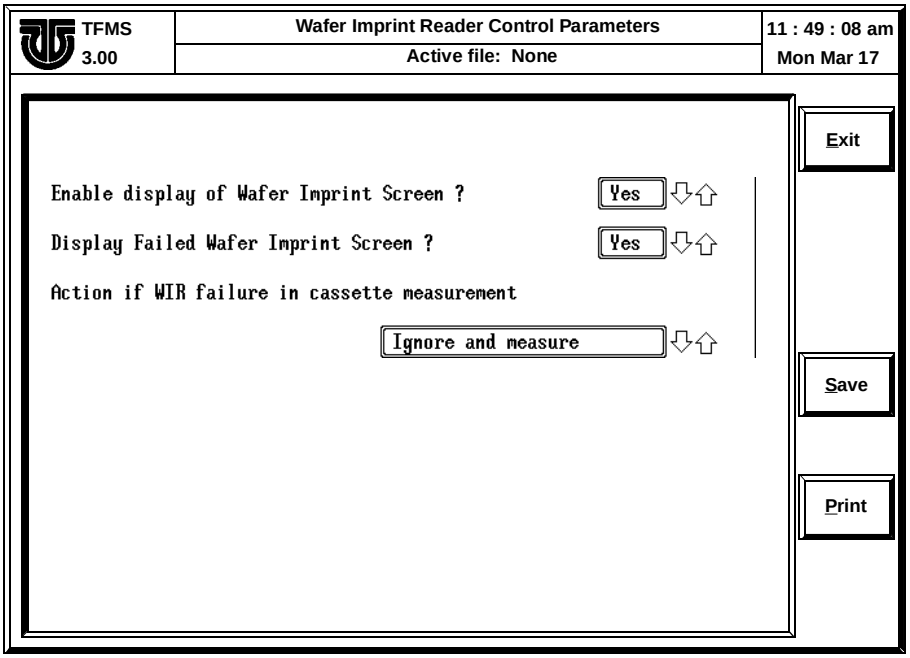
Control params

When you select this option in the *Administration*/*Wafer Imprint* menu, the Wafer Imprint Control Parameters window appears, as shown in Figure 7.51. In this window, you can set up the WIR display parameters and configure the WIR error controls.

Enable display of Wafer Imprint Screen? Specifies whether the system displays the wafer imprint information at runtime. This parameter overrides the *Setup*/*Recipe*/*Wafer imprint* display parameters.

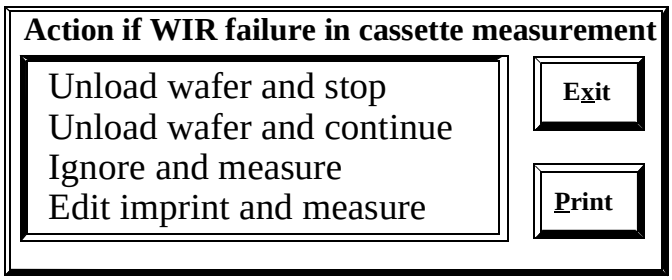
Display Failed Wafer Imprint Screen? Specifies whether the system displays failed wafer imprint information at the end of a cassette measurement.

Figure 7.51 WIR Control Parameters window



Action if WIR failure in cassette measurement?Specifies the system's response during a cassette measurement if one of the wafers fails a Wafer Imprint reading. You can select from one of the options in the pop-up menu shown in Figure 7.52.

Figure 7.52 WIR failure pop-up menu



Unload wafer and stop:Specifies that the system unloads the problem wafer and discontinues the cassette measurement process.

Unload wafer and continue:Specifies that the system unloads the problem wafer and continues the cassette measurement process.

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Ignore and measure: Specifies that the system measures the problem wafer and continues the cassette measurement process.

Edit imprint and measure: Specifies that the system allows the operator to manually enter the problem wafer's imprint, measure that wafer, and then continue the cassette measurement process.

7.4 SECS MENU

If your system has SECS installed, you can access additional System Manager functions in the SECS setup menu. For a description of these functions, see the separate "SECS II Manual."

7.5 JOB FILE MANAGEMENT

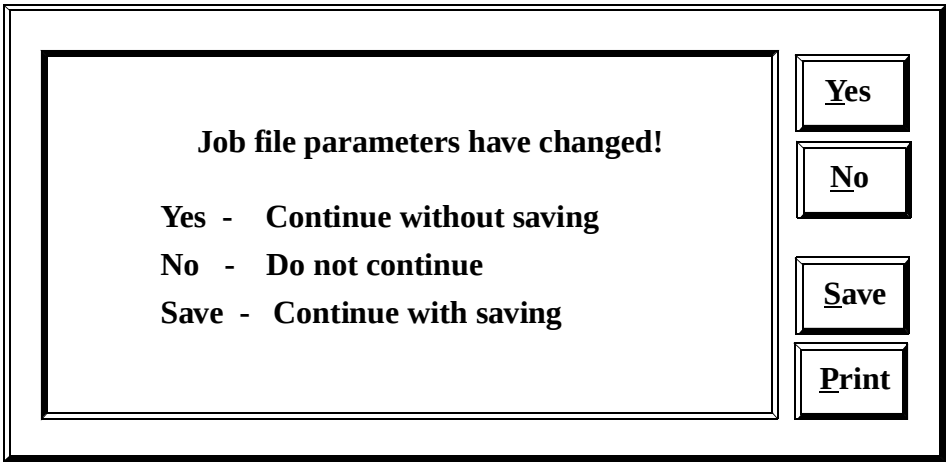
Every Opti-Probe job file (and job file chain) has an owner with a user level and the corresponding access privileges, as described in your "Getting Started" manual. In most cases, the creator is the owner. As a System Manager, you have change privileges for all job files, except those that are owned by Therma-Wave. This allows you to fix problems and restore a job file's integrity. In addition, at the owner's request, you can rename and delete job files, and remove data to manage disk space. You can also change the ownership of a job file whenever it is necessary.

7.6 LOGGING OUT

When you're finished using the System Manager functions, select the *Exit* button to return to the Main Menu window, and then select the *Logout* button. This returns the system to the Operator level and secures it against unauthorized use. If you did not change any parameters during the current login, the system logs you out. If you did change any parameters, a dialog box appears with a warning message, as shown in Figure 7.53. Select *Yes* to continue without saving your changes, *No* to cancel the Logout, or *Save* to save your changes. If you select *Yes* or *Save*, the system logs you out accordingly and either closes the job file or keeps it open, as specified by the System parameters, described earlier in this section. If a

job file remains open with unsaved changes, none of these changes are saved when a user opens another job file.

Figure 7.53 Job file parameters changed dialog box



A

SAFETY

Contents

- Safety and operating precautions A-2
- Replacing the UV Deuterium (D2) bulb A-30

A.1 SAFETY AND OPERATING PRECAUTIONS

This section covers laser, electrical, and mechanical safety and operating precautions for all Opti-Probe models. UV safety information and instructions for replacing the UV deuterium (D2) bulb are provided later in this section.

A.1.1 Laser safety

The Opti-Probe contains a Class IIIb diode laser product that meets all FDA Compliance Department for Radiological Health (CDRH) standards. During normal operation, no laser radiation is accessible to the user. If you open the top cover, all power is turned off, even if you do not remove the optics cover. Additional interlocks can be added through the EMO switch jumper at the back of the system. All service related entry to other sections of the system must be performed by Therma-Wave personnel.

To prevent injury and equipment damage, you should read all the warning and caution information in this section before using the system.

The Opti-Probe's diode laser has a wavelength of 670 nanometers (nm). The maximum output of the laser diode is 10 milliwatts (mW), with a 0.75mW to 1.5 mW normal operating range. The laser power can only be modified by adjusting the LEVEL SET potentiometer on the laser driver, which is only done when the laser is calibrated or replaced.

The side panels, pop-top, and front door are interlocked. Never defeat the interlocks. If you defeat the interlocks in an unauthorized entry, the system power and laser driver power automatically shut down.

Warning: Do not defeat Interlocks

Study the following warnings and information carefully. Operate the laser in strict compliance with the precautions, warnings, and procedures provided in this manual. Failure to comply with this information can cause personal injury.

*Class IIIb lasers are defined as laser or laser systems that can produce a hazard if viewed directly. This includes intrabeam viewing of specular reflections. Normally, Class IIIb lasers do not produce a hazardous diffuse reflection.

With all panels secured during normal machine operation, the Opti-Probe is rated as a Class 1 machine and poses no hazard.

***Warning:* Serious eye injury can result from looking at the laser beam. uring operation to avoid injury. Avoid exposure to the laser during operation to avoid injury. Do not view a direct laser beam.**

The following steps are required to ensure laser safety in the work area.

1. Establish and maintain a controlled access area for laser operation
2. Limit access to personnel who are trained in laser safety principles
3. To avoid unnecessary radiation exposure, keep the laser's protective housing in place during normal operation.

***Warning:* Serious eye injury can result from looking at the laser beam. Confine the laser beam to the laser operation area. The laser beam is high and dangerous even at a great distance.**

4. Post visible warning signs near the laser
5. Set up shields to prevent stray reflections from escaping the laser operating area

***Warning:* Do not place reflective objects into the beam. Laser light scattered from a reflective surface can be as damaging or harmful as the original beam.**

6. Provide enclosures for laser beam paths whenever possible

7. Remove rings, watchbands, etc. before operating the laser.

8. Never leave the laser ON, Open, or Unattended

Avoid exposure during laser maintenance/service

To eliminate the possibility of laser radiation exposure, observe the following guidelines:

- Do not remove the optics cover if any side panels are removed or the front door is open.
- Do not remove the optics cover unless it is absolutely necessary. If you have to remove the optics cover to service the optics plate, replace the cover immediately after completing the work.
- Always leave the optics cover on the measurement system when you service the machine at eye level (40 inches to 45 inches from the floor).
- Never operate the laser diode outside the system. The laser diode should always be mounted before applying and turning on power.
- Keep shiny or reflective tools out of the laser beam path to prevent accidental scattering of radiation.

CDRH Maintenance Requirements

The Opti-Probe's laser complies with Title 21 of the "United States Code of Federal Regulations, Chapter 1, Subchapter J, Parts 1040.10" (as applicable). To maintain compliance, verify the operation of all features listed below, annually or when the laser is subjected to adverse conditions (e.g., fire, flood, mechanical shock, spilled solvents, etc.).

- Verify that removing the service access panels prevents laser operation.
- Verify that all safety interlocks stop emissions of the laser or collateral radiation when the service panels are removed.

- Verify that operation of the remote interlock switch prevents laser operation.
- Verify that the emission indicator emits a visible signal when the laser is on. A red lamp on the laser diode power supply indicates the laser is in operation.
- Verify that the beam blocker blocks exposure to laser radiation when activated.

Laser radiation and diode laser labels

The laser radiation label and the diode laser label, shown in Figures A-1 and A-2, are affixed to each interlock position, the optics plate, and all covers and doors, as shown in Figures A-10, A-11, A-13, A-15, A-16, A-17, and A-19. In addition, these labels are affixed to the diode laser head.

Figure A.1 Laser radiation label

Figure A.2 Diode laser label

A.1.2 Electrical safety

Due to electrical voltages contained within the Opti-Probe, all electrical safety procedures must be observed when servicing and maintaining the system.

Authorized personnel should verify the operation of all system features annually, or if the system is subjected to adverse conditions (e.g., fire, flood, mechanical shock, spilled solvents, etc.). Use nonconductive tools (such as insulated

screwdrivers, etc.) whenever performing any adjustments or maintenance on the Opti-Probe.

Emergency OFF (EMO) button

In an emergency, you can turn off all power to the system by pressing one of the EMO buttons. All standard Opti-Probe models have one EMO button located at the front of the cabinet, as shown in Figure A-10. Bulkhead systems (Model 2600B) have one EMO button affixed to the Operator module, as shown in Figure A-16, and two additional EMO buttons affixed to the back and front of the Measurement module, as shown in Figures A-19 and A-20.

You should only press an EMO button in an emergency to turn off all power to the system.

Warning: **The Opti-Probe contains several 200-240 volt AC powerconnections. When you press an EMO button, there is stilla risk of electrical shock with the doors or panels open. Toavoid this risk, unplug the unit.**

Caution: **Under normal operating conditions, do not power down the system using an EMO button instead of the standard shut down procedure. This action can cause errors inthe wafer handling system. If a shut down is necessary under normal conditions, only authorized trained users should perform this function. For a description of the shutdown procedure, see "ON/OFF switch" earlier in this section.**

After an emergency shutdown, follow these steps before you resume normal operations:

1. Resolve the problem that required the emergency shutdown
2. Before you restore power: check the system's stability and mounting and all electrical, utility, and communications connections. Make sure the system's restricted area is vacated.
3. Restart the system and make sure it initializes completely, (including the TFMS software)
4. Unload any remaining wafers.

The Opti-Probe automatically recovers any wafer that is left in the system during an emergency shutdown. You'll see a message displaying the cassette status of any recovered wafer.

An emergency shutdown can cause some file corruption. If any corruption occurs, the System Manager must restore the appropriate hard disk files from the backup tape(s).

ON/OFF switch

Caution: **The System Manager can only restore those files that were copied to the backup tape(s) during the last backup session. Any files saved since the last backup cannot be restored.**

The Opti-Probe has an ON/OFF rocker switch located on the left side inset, as shown in Figure A-10. When this switch is in the OFF position, all electrical circuits are shut down, except the 24 Vac control circuit.

Lock-out, tag-out feature

The main AC/DC breaker switch box, shown in Figure A-19 provides a lock-out, tag-out feature as a fail safe measure. Once you turn off AC power at the breaker, the plexiglass cover can be closed and locked with a key. Power cannot be re-activated except with this key. Only service personnel should have access to this key.

Warning: **This machine contains several 115-volt power connections. Although these connections are well covered with plexiglass shields to prevent injury, use extreme caution when the door or panels are open.**

Electrical warning and caution labels are located throughout the system.

High voltage label

The high voltage warning label, shown in Figure A-3, is affixed to the lower electronics drawer at the front of the system, to the main power box at the back, to the upper right corner of the service access panel for the Model 2600B measurement module's wafer handling system, and to the areas above the wafer handling system's power supplies (behind the service access panel), as shown in

Figures A-12, A-13, A-18, and A-19. In addition, this label is also affixed to the white light power supply, electric box assembly, programmable logic controller, and to the plexiglass cover of each 115 volt alternating current (vac) terminal strip. On DUV systems, the high voltage warning label is affixed to the white light, deuterium, and tungsten power supplies, the robot controller, and the UV interlock assembly box, shown in Figures A-24 and A-25.

Figure A.3 High voltage label

Over current protection label

The over current protection label, shown in Figure A-4, is affixed to the main power box at the back of the system, as shown in Figure A-19.

Figure A.4 Over current protection label

Chassis ground label

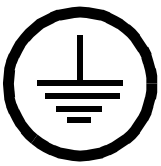
The chassis ground label, shown in Figure A-5, is affixed inside the AC power drawer, located above the card cage, as shown in Figure A-14.

Figure A.5 Chassis ground label

Line in ground chassis label

The line in ground chassis label, shown in Figure A-6, is affixed to the AC/DC power box on the left side of the system, as shown in Figure A-15.

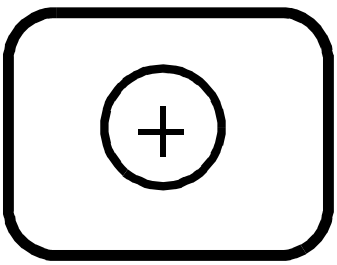
Figure A.6 Line in ground chassis label



EMO label

The EMO yellow background label, shown in Figure A-7, is affixed below each EMO button, as shown in Figures A-10, A-16, A-19, and A-20.

Figure A.7 EMO yellow background label



Diode laser driver (Melles Griot)

The Melles Griot 56DLD403 is a high performance laser driver and thermoelectric cooler controller. This device stabilizes the temperature by using the standard AD590 mode and monitoring the heat at the diode junction. The diode laser driver supplies power to the laser, controls laser output, and monitors laser junction current and temperature. The laser driver must be matched to the laser head for proper performance. Laser radiation and diode laser warning labels (shown in Figures A-1 and A-2) are affixed to the diode laser head.

Safety Interlock Circuits

EMO Interlock Circuit 1:Interlock Circuit 1 consists of a 24-volt AC relay coil that is wired in series to the EMO button at the front of the system, its access panel interlock switches, the bypass switch behind the front cabinet, and the remote switch on the rear panel. If you open the access panels or top lid cover, or if you press the EMO button, the diode laser and the power to the system turn off. The bypass switch located behind the right panel (front panel of the 2600B) can be activated to allow authorized personnel to service the system.

EMO Interlock Circuit 2:Interlock Circuit 2 consists of 24-volt AC time delay relays with air flow switches located in the exhaust ports of the air cooled system electronics. Interlock Circuit 2 is wired with Interlock Circuit 1.

UV Interlock Circuit 3 (DUV systems only):Interlock Circuit 3 consists of two switches connected in series through connector J4. When 24 volt DC is applied to the interlock box through connector J6 and both the SW1 and SW2 interlock switches are closed, the K1 relay and the LP1 red lamp are energized. The normally open contacts K1/4,7 and K1/6,9 then close and the AC hot line to the tungsten and deuterium power supplies is connected through J2 and J3. At this point both light sources begin to operate.

When the light source cover is removed to access either of the lamps, both interlock switches break the line for the K1 relay, which turns off both the tungsten and deuterium power supplies.

A.1.3 User safety

The Opti-Probe is designed to operate safely without injury to the user if all doors and panels are closed. Any deviation from this practice can cause hardware damage or personal injury. Following is a list of mechanical safety precautions:

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1. Do not operate the system with a door or panel open. This can result in electrical shock and/or laser exposure. Use extreme caution at all times. In addition, operating the system with a door or panel open can affect the Opti-Probe's internal ambient temperature, severely impairing the system's performance and stability.

2. Do not press an EMO button unless there is an emergency. If you push an EMO button, the system automatically shuts down all electrical circuits except the 24 Vac control circuit. EMO buttons for all systems are shown later in this section.

3. Keep hands and all objects away from the X-Y stages and wafer handling mechanism while they are in motion.

4. Contact the Therma-Wave Field Service Department at 1-800-992-3321 (24 hours at day if you see a message saying the Opti-Probe requires service. Do not use the system until the problem is resolved.

Hands away mechanical safety label

The hands away mechanical safety label, shown in Figure A-8, is affixed to the left and right sides of all models except for Model 2600B where it is affixed only to the left side of the measurement module, as shown in Figure A-17.

Figure A.8 Hands away mechanical safety label

Air pressure maximum label

Warning: **Keep hands and arms away from all pinch points. Pinch points include those between the poptop cover and frame hinged panels on the pop topcover, side panels on the measurement module, the wafer handler module and frames, the electronics card cage door, the electronics box, and the operataor panel front door frame.**

The air pressure maximum label, shown in Figure A-9, is affixed above the air line at the back of all models, as shown in Figure A-19.

Figure A.9 Air pressure label

Solvents and Chemicals

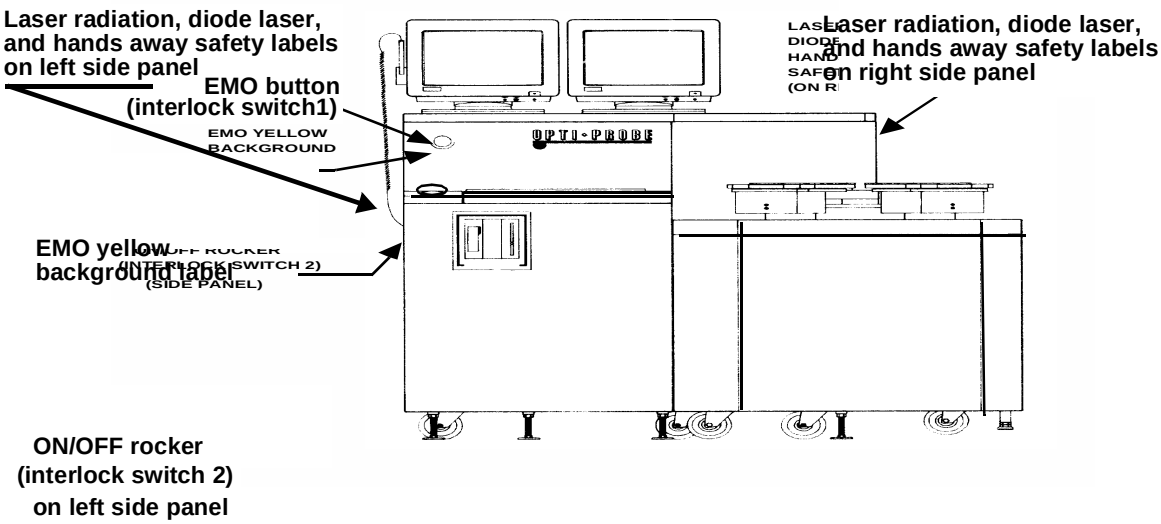
For the cleaning solvents and other chemicals used for maintaining the equipment the customer should request a Material Safety Data Sheet (MSDS) from the chemical supplier when purchasing the chemical. Therma-Wave does not supply these documents; it is the customer's responsibility.

A.1.4 Safety labels

Most Opti-Probe models have a red EMO button with a yellow background label affixed to the front left side, two EMO interlock switches located on the left side,

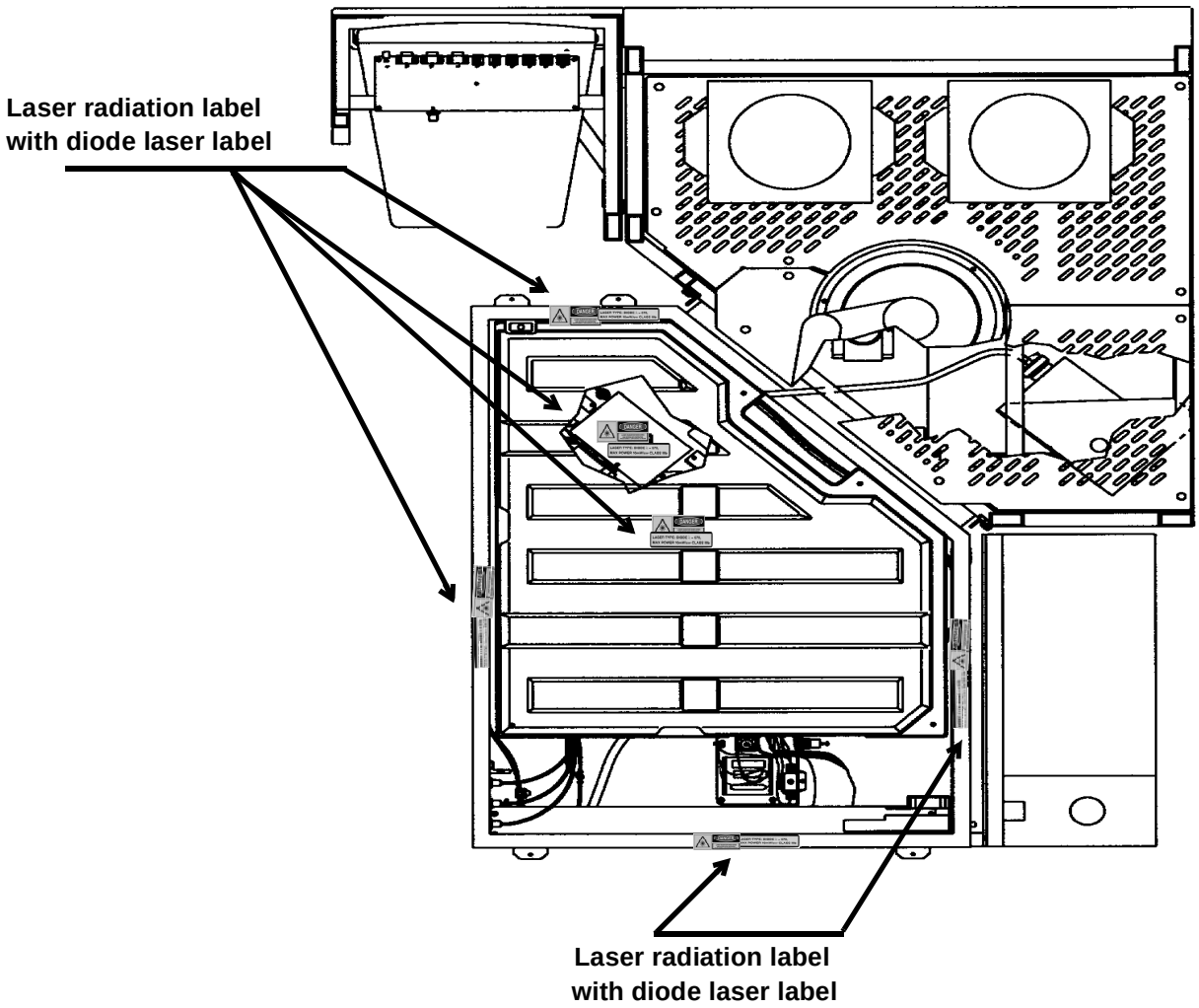
and laser radiation, hands away, and diode laser labels affixed to the left and right sides, as shown in Figure A-10.

Figure A.10 Standard Opti-Probe safety labels/Interlock switches


Laser radiation, diode laser, and hands away safety labels on left side panel
EMO button (interlock switch1)
EMO YELLOW BACKGROUND
EMO yellow background label
(SIDE PANEL)
ON/OFF rocker (interlock switch 2) on left side panel
Laser radiation, diode laser, and hands away safety labels on right side panel
OPTI-PROBE

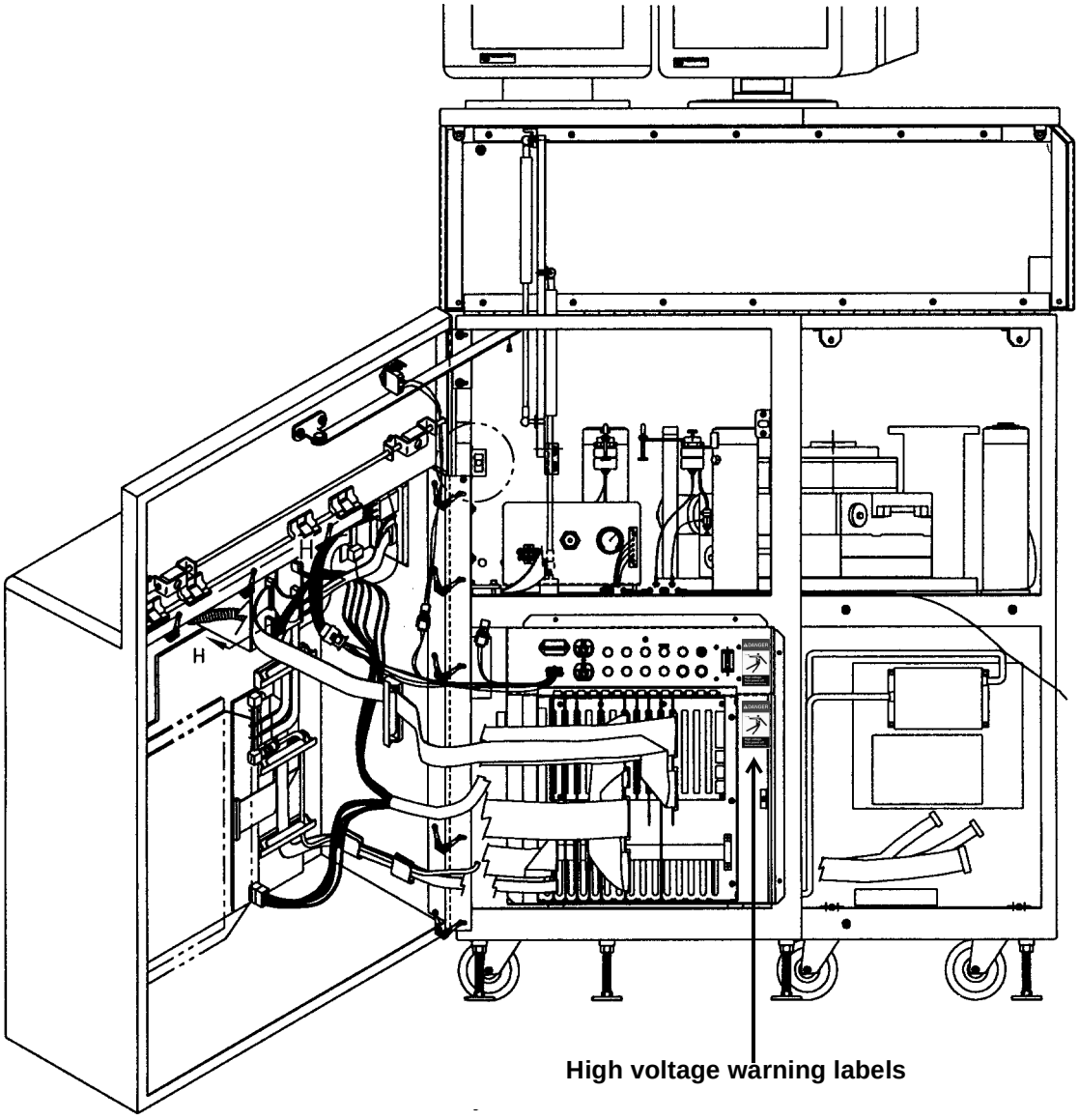
All Opti-Probe models have laser radiation labels and diode laser labels affixed to the Optics plate, as shown in Figure A-11.

Figure A.11 Optics plate laser radiation safety labels



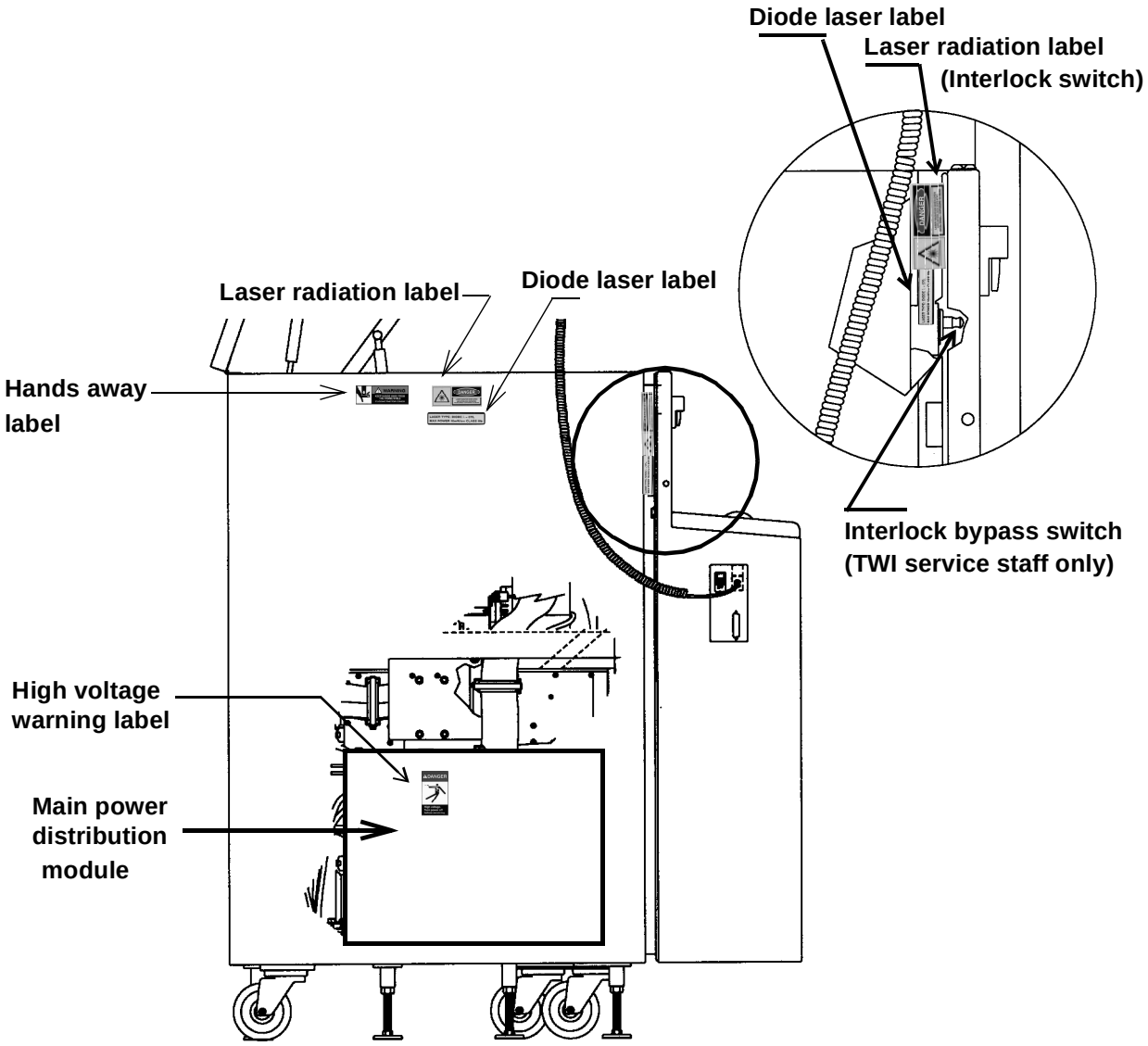
All Opti-Probe models have two high voltage warning labels affixed to the lower electronics drawer, near the CPU, as shown in Figure A-12.

Figure A.12 High voltage label locations



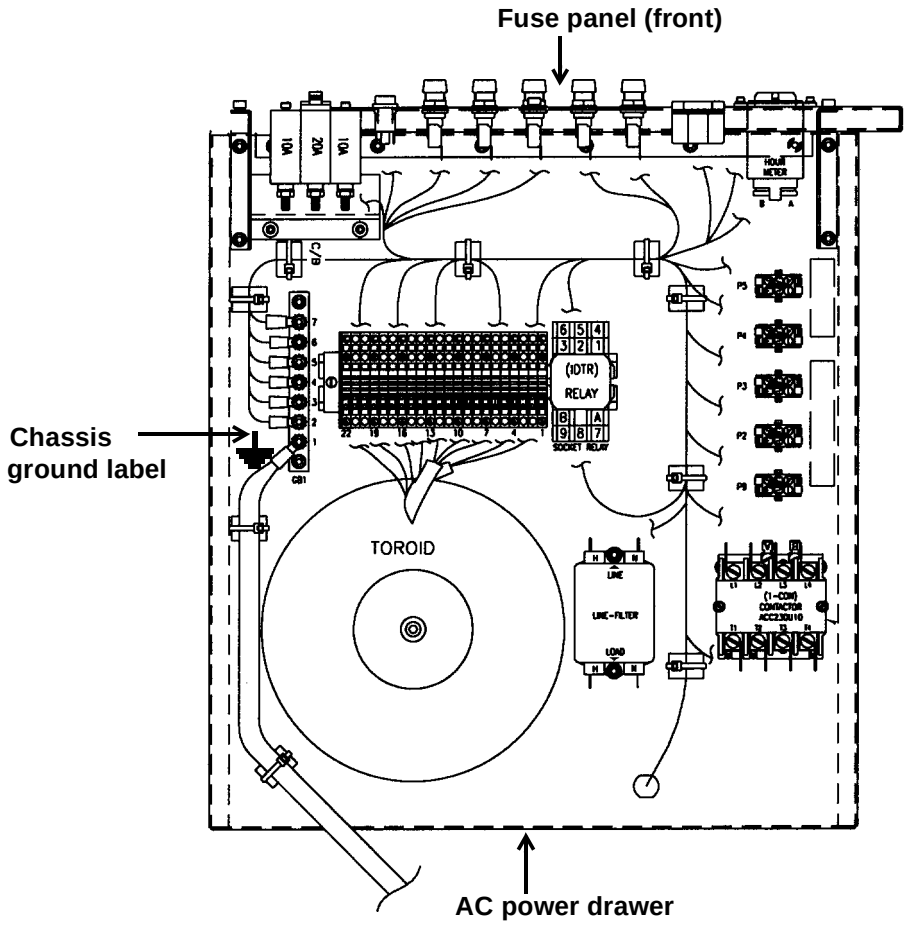
All Opti-Probe models have two EMO interlock switches on the left side, and a high voltage warning label affixed to the Main power supply, as shown in Figure A-13.

Figure A.13 Detail EMO interlock switches 1 and 2 and main power supply safety labels



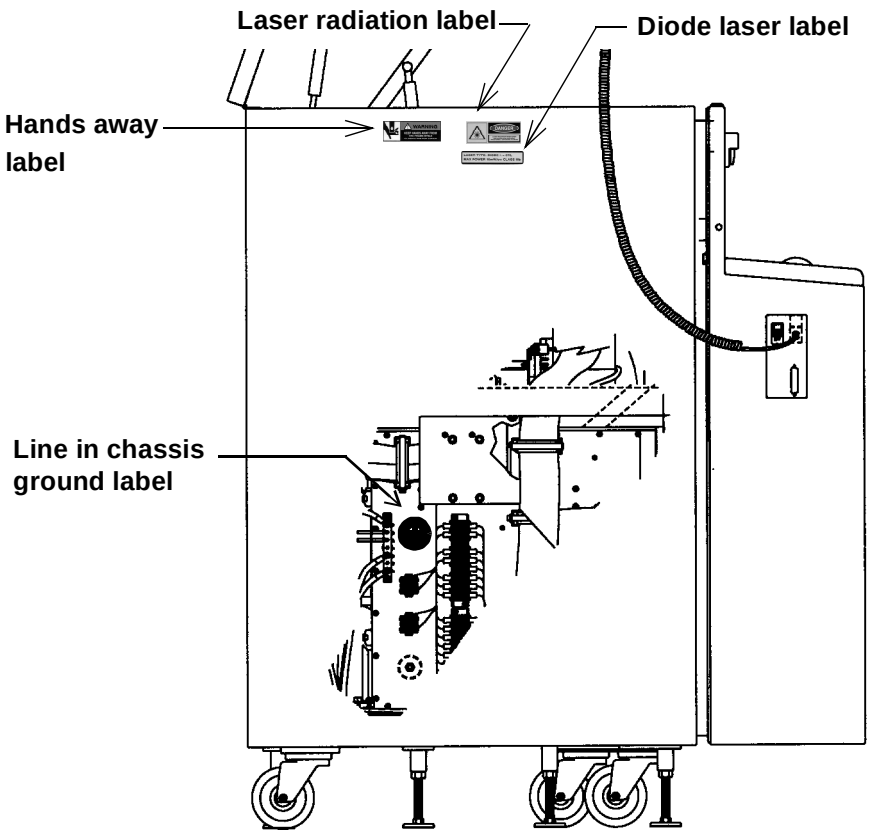
All Opti-Probe models have a chassis ground label affixed inside the AC power drawer, as shown in Figure A-14.

Figure A.14 Chassis ground label location



All Opti-Probe models have a Line in chassis ground label affixed to the AC/DC power box, and Laser radiation and Diode laser labels affixed to the left and right sides of the system. Figure A-15 shows a left side view.

Figure A.15 Line in chassis ground label (left side view)



2600B operator module EMO button and measurement module safety labels

Figure A-16 shows the EMO yellow background label, Laser radiation labels and Diode laser labels, on the Model 2600B operator module (front view) and measurement module (right side).

Figure A.16 Model 2600B operator module (front view) measurement module (right side)

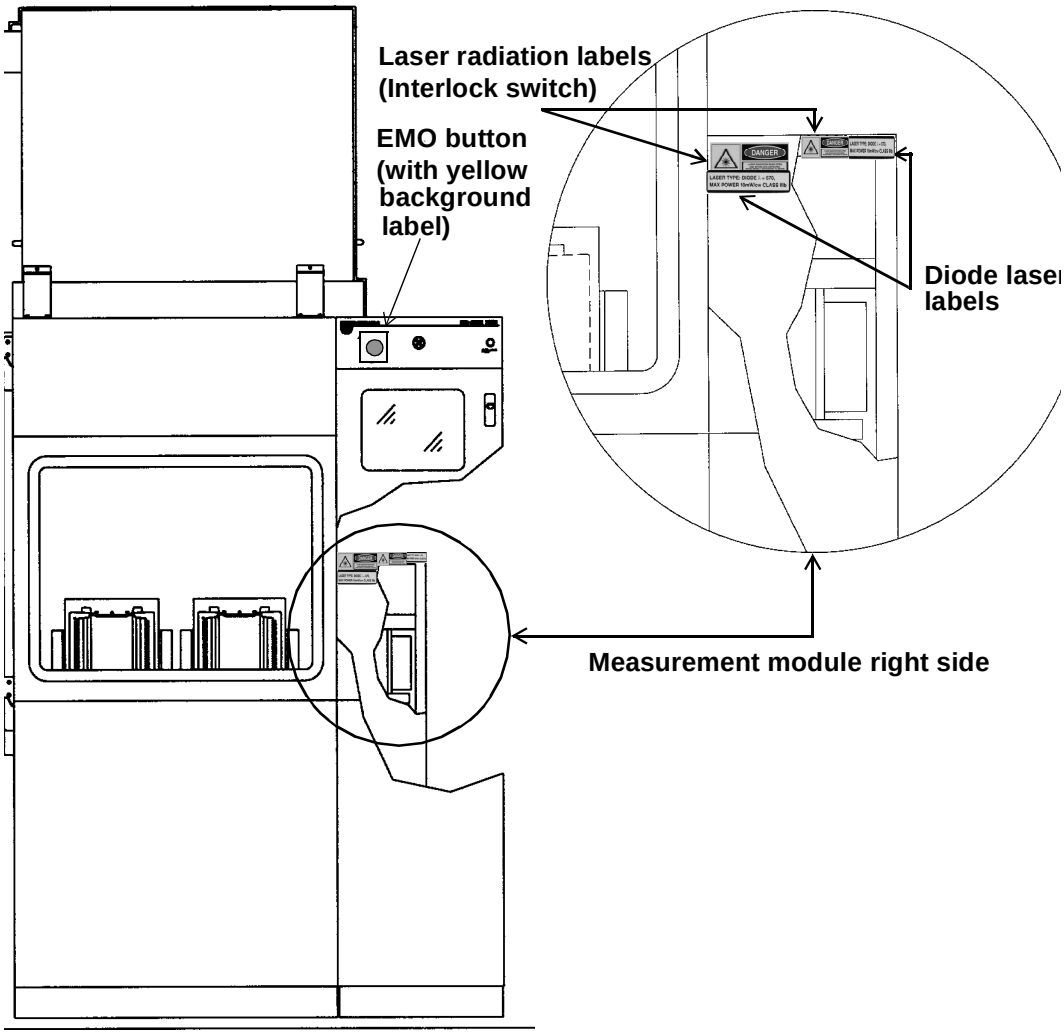


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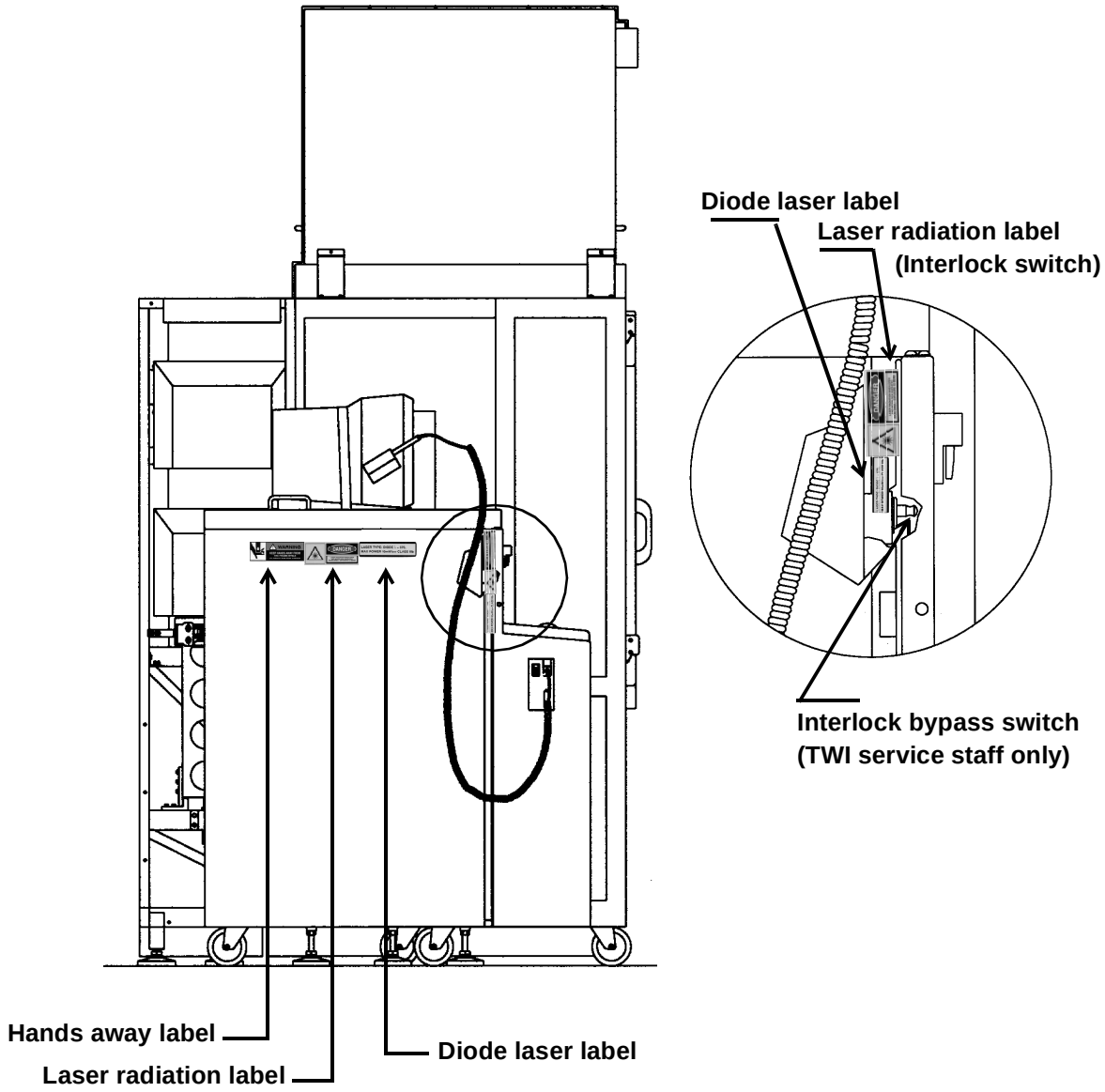
Figure A-17 shows the Laser radiation labels, Diode laser labels, and Hands away label on the Model 2600B measurement module (left side).

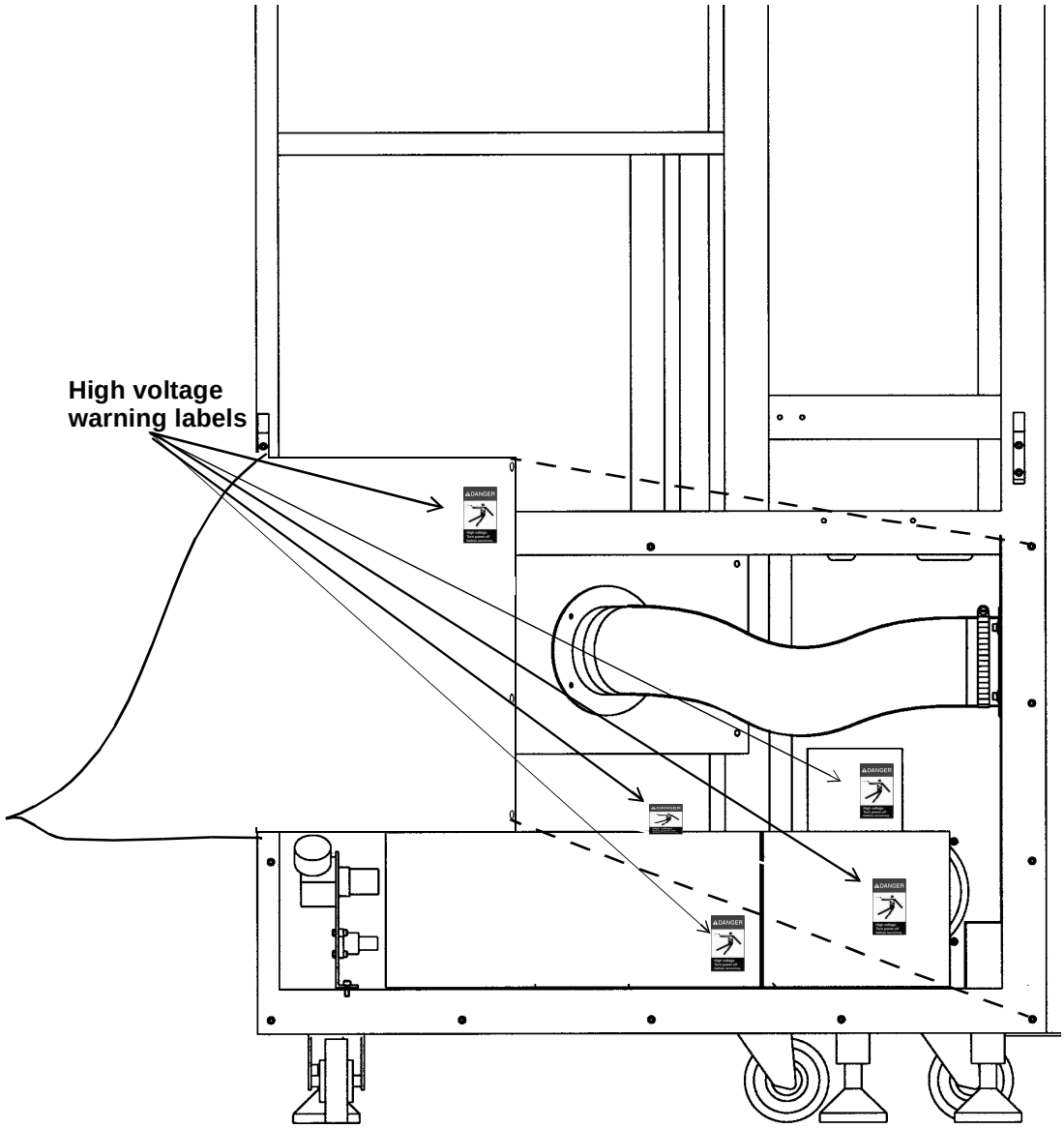
Figure A.17 Model 2600B measurement module (left side) operator module (rear view)



Three high voltage warning labels are affixed to the left side of the Model 2600B measurement module's wafer handling system. One is located on the upper right

corner of the service access panel, and two are located above the power supplies (behind the service access panel), as shown in Figure A-18.

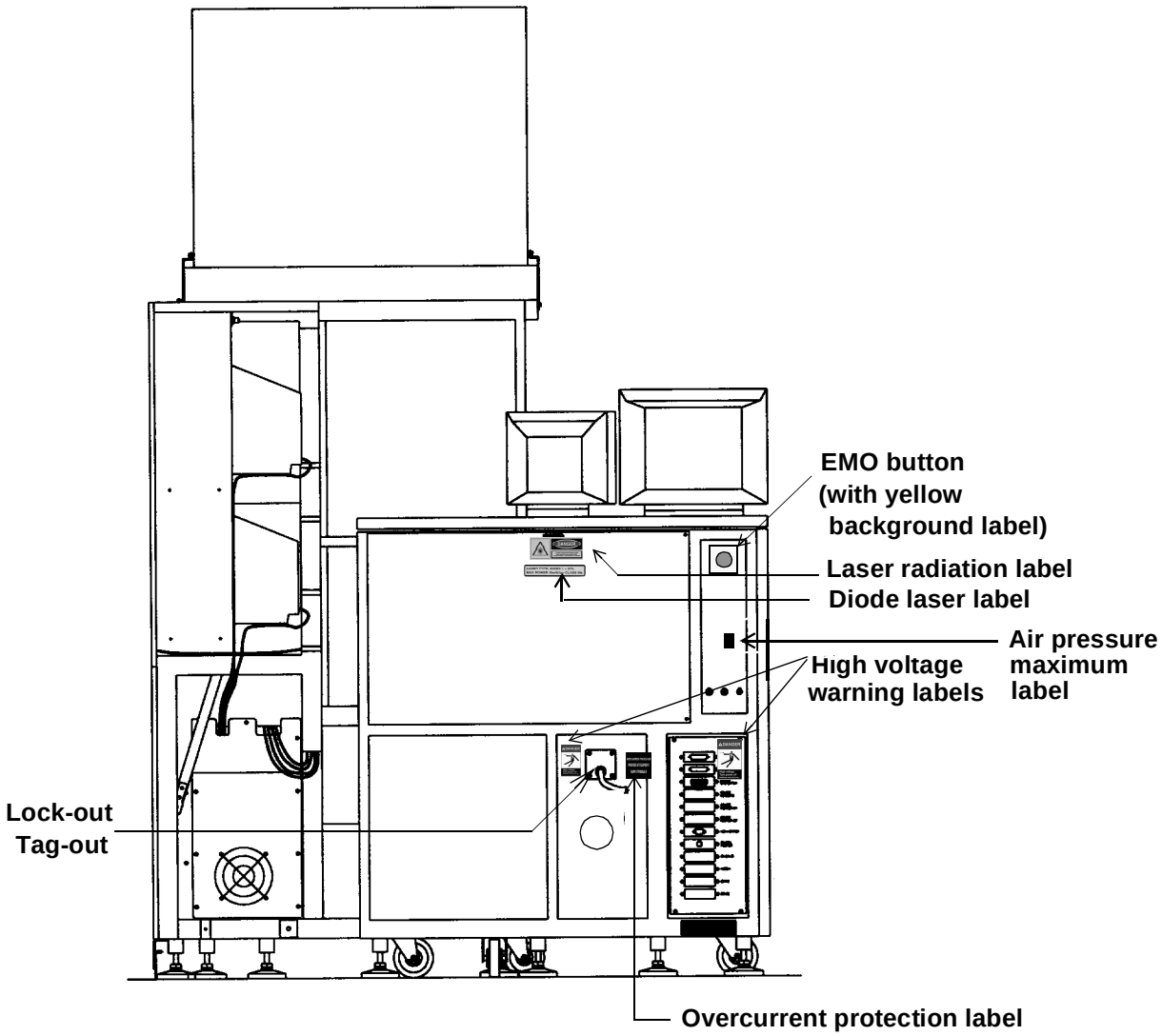
Figure A.18 Model 2600B measurement module wafer handling system (left side) (service access panel removed)



2600B rear measurement module/EMO button
Rear safety labels and lock-out, tag-out for all models

Figure A-19 shows the EMO button (with yellow background label) on the 2600B measurement module (rear view). It also shows the Lock-out, Tag-out and the Laser radiation, Diode laser, Air pressure maximum, High voltage warning, and Overcurrent protection labels as they appear on the rear of all Opti-Probe models.

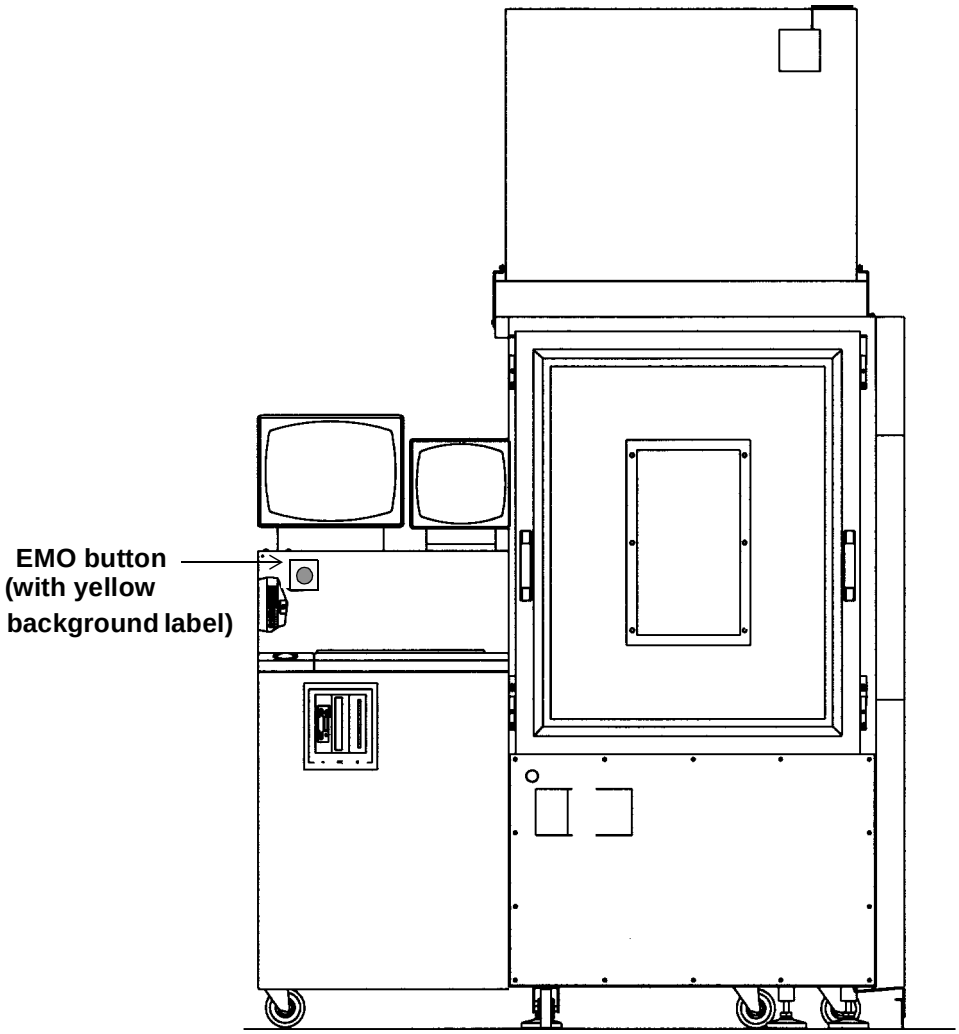
Figure A.19 Model 2600B measurement module (rear view)
Operator module (right side)



2600B measurement module front EMO button

Figure A-20 shows the EMO button (with yellow background label) on the Model 2600B measurement module (front view).

Figure A.20 Model 2600B measurement module (front view) Operator module (left side)



A.1.5 Ultra-violet (UV) safety

The Opti-Probe has an Ultra-violet (UV) light source installed in some models (currently Models 2600 DUV/DUVI). The UV light source emits its maximum UV

output energy at 165 nm. Therma-Wave only uses energy in the 190 nm to 600 nm range. A protective glass window shields the UV deuterium bulb and does not allow the transmission of any wavelength below 190 nm.

The side panel covering the UV source is interlocked. If the interlocks are defeated in an unauthorized entry, the system remains active, but the power to the UV deuterium bulb is shut down.

***Warning*: Do not defeat the interlocks.**

Study the following warnings and information carefully.

***Warning*: Operate the UV with strict compliance to the following precautions. Follow only the procedures stated in this manual cause Failure to comply with precautions and procedures can cause personal injury. Avoid exposure to the UV during installation, maintenance, service or operation.**

Warning: To avoid eye injury, never attempt to view the UV arc directly. Always wear protective goggles when performing maintenance and service.

During normal operation, if all the Opti-Probe's panels are secured, there is no danger to the user.

The following steps are required to ensure UV safety in the work area.

1. Establish and maintain a controlled access area for UV operation.

2. Limit access to personnel who are trained in UV safety principles..

***Warning:* Ensure that the UV light remains confined to the operation area. The energy in UV light can sunburn unprotected eyes.**

Warning: **Do not allow reflective objects to be placed into the UV light UV light scattered from a reflective surface can be as damaging or harmful as the original light. Remove any rings, watchbands, etc. before operating the UV.**

To avoid unnecessary radiation exposure, keep the UV protective housing in place during normal operation

- Post visible warning signs when servicing the UV light source
- Provide enclosures for UV light paths whenever possible
- Set up shields to prevent stray reflections from escaping the UV operating area
- Provide enclosures for laser beam paths whenever possible
- Never leave the laser ON, Open, or Unattended

The UV radiation label and the heat warning labels shown in Figures A-21 and A-22, are affixed to the top of the UV source cover, (Figures A-23, A-32) and the D_2 bulb housing (Figure A-33).

Figure A.21 UV radiation warning label

Figure A.22 UV heat warning label

On DUV systems, the high voltage warning label (shown earlier in this section in Figure A-3) is affixed to the white light, deuterium, and tungsten power supplies, the robot controller, and the UV interlock assembly box, shown in Figures A-24 and A-25.

DUV Safety Label Locations

Figure A.23 Source cover with UV radiation and heat warning labels (outer panel removed)

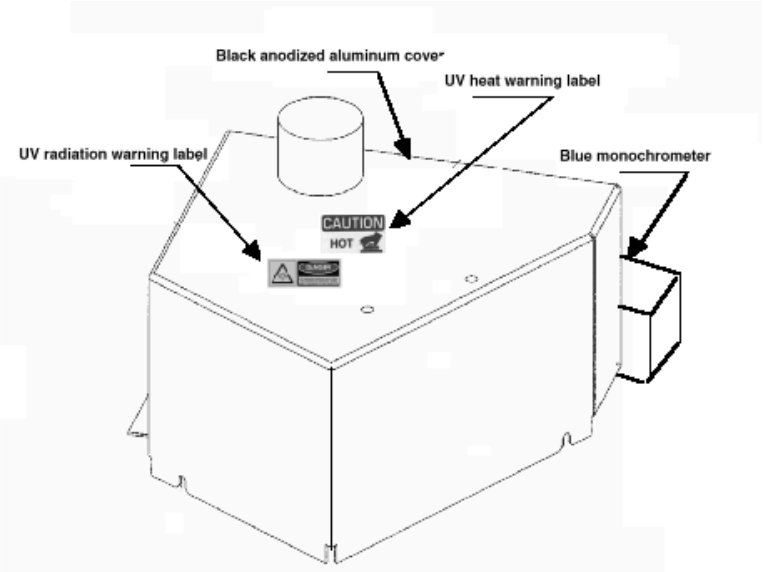


Figure A.24 DUVI (Indexer) power supplies (under panel) High voltage labels

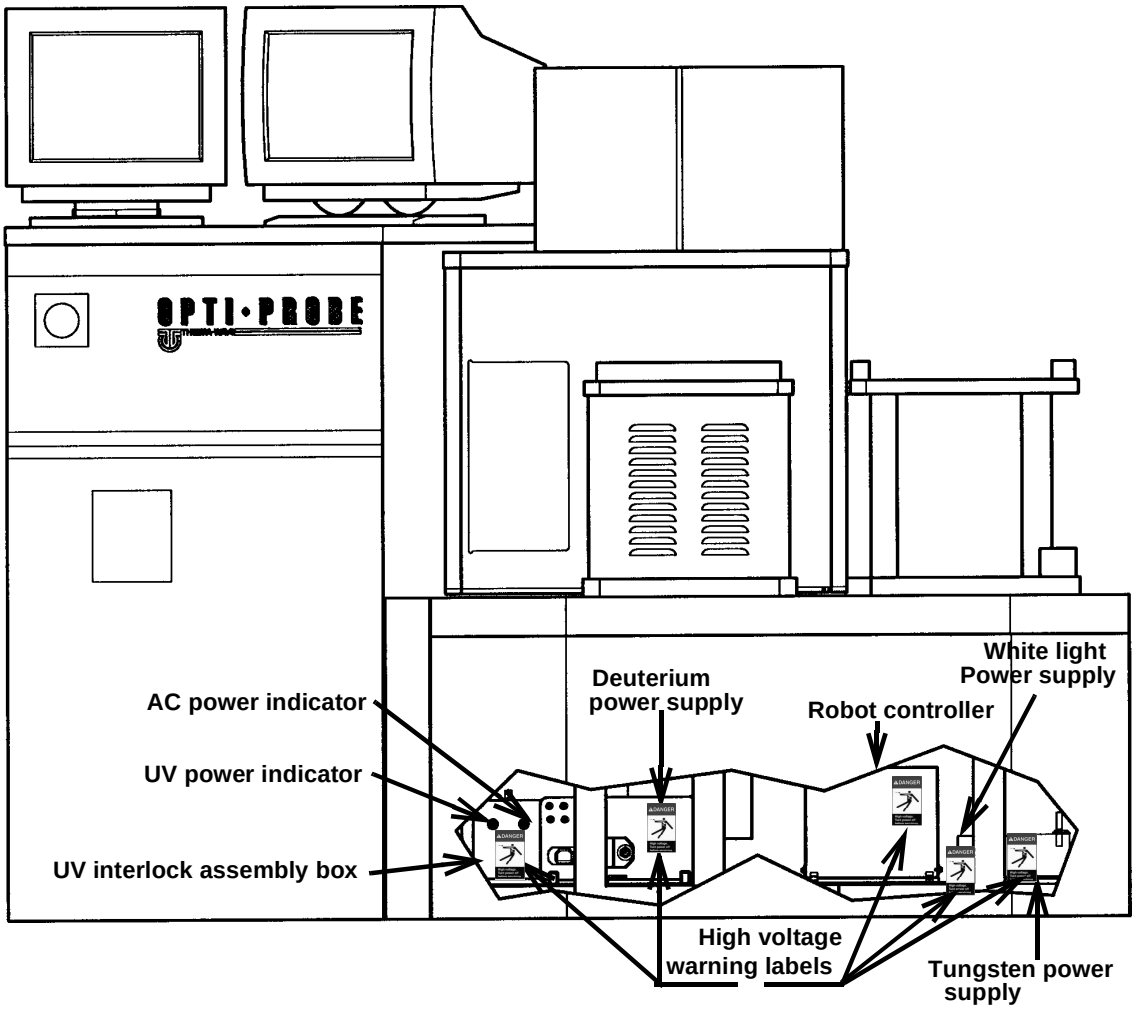
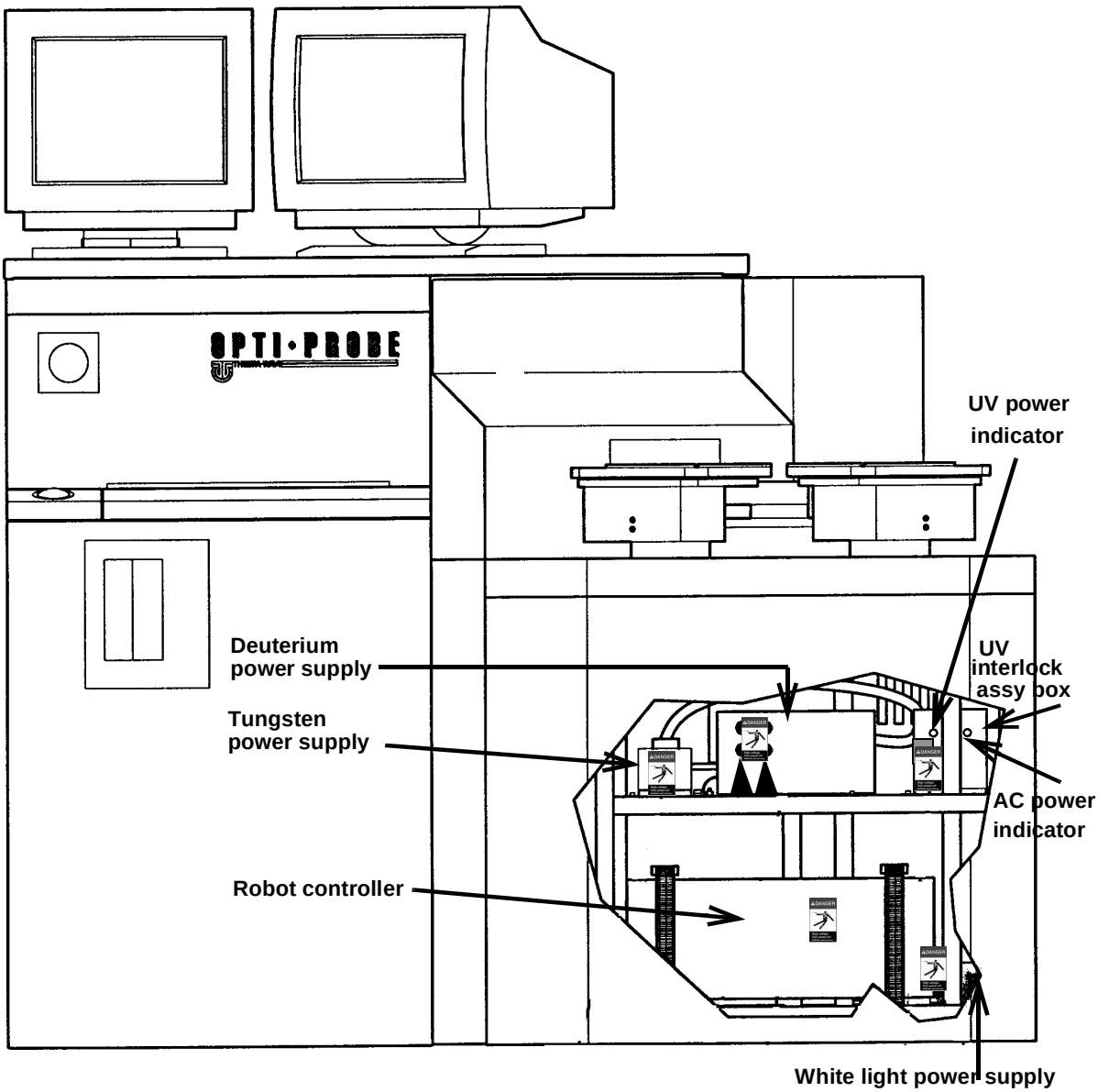


Figure A.25 DUV power supplies (under panel) High voltage labels



A.2 REPLACING THE UV DEUTERIUM (D_2) BULB

A consumables kit is provided with all DUV/DUVI systems. This kit (PN 61-013906) includes six replacement deuterium bulbs for DZ lamp at 200 nm (PN-29-013586). An optioanl EUV DZ lamp at 193 nm can be ordered for the OP 3260 and the OP 2600 (PN: 29-014965). To re-order these items, use the referenced part numbers.

The following procedure should only be performed by individuals who attended and passed Therma-Wave's Maintenance Training Course.

Required tools

- Clean gloves
- Hex-key 5/32" and 3/32"
- Screwdriver
- Preparation for bulb replacement

1. Remove the new D_2 bulb from the box outside the cleanroom.

   Deuterium (D_2) bulbs are not packaged in cleanroom materials.

2. Keep the bulb in the plastic bag until you install it.

   Do not touch the D_2 bulb glass with bare fingers. Use clean room gloves to handle the bulb. Finger oil burns the bulb and absorbs light that can damage the glass envelope and shorten bulb life.

A.2.1 Removing the UV D_2 bulb

Danger:

Do not look directly at the energized D_2 bulb. It is not necessary to wear safety goggles if you do not look at the energized D_2 bulb

1. Check for purple light shining from the D_2 enclosure before changing the UV D_2 bulb.

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If you see purple light, the bulb is running and UV light is present.

2. Shut off power to the UV bulb.

3. Remove the silver outer cover, shown in Figures A-26 (DUV) and A-27(DUVI). Release the spring-loaded screw. To release the latch, rotate the 5/32" hex-key opening counterclockwise (CCW) for less than 180°.

   Do not touch the two small button head hex-screws at the bottom of the cover.

4. Slide the cover approximately 4" out and away from the main frame.

   When you remove the outer cover, the power to both UV sources

5. Verify that the interlock shut off the power supplies, and then remove the robot module front panel with the 5/32" hex-key, as shown in Figures A-28 (DUV) and A-29 (DUVI).

CAUTION: **This procedure and access areas that open with a tool key are restricted to personnel who are qualified by TWI in Preventive Maintenance.**

6. The UV Interlock assembly box, shown in Figures A-30 (DUV) and A-31 (DUVI) has two indicator lights. If the red light labeled "UV power" is not on, power to the UV lamp is off, and you can safely remove the UV source cover.

7. Lift the silver outer panel cover (Figures A-26, A-27) away from the machine. Slide it back and forth to release it from the guides, if necessary.

8. Under the outer silver cover there is a black anodized aluminum UV source cover and a blue monochrometer, shown in Figure A-32

   Do not touch the blue box or the system will not remain calibrated**.**

At this time, the UV source cover should be warm, but not hot.

8.1 Remove the black UV source cover. Loosen the two black thumb screws along the sides of the UV source cover, as shown in Figure A-32

8.2 Remove the captive spring screw until it pops up, as shown in Figure A-32.

8.3 Carefully lift off the black UV source cover vertically, without disturbing the components on the source cover base plate, and then set the cover aside.

9. When you remove the UV source cover, the D_2 and tungsten housing boxes are visible, as shown in Figure A-33. The larger box toward the front, is the D_2 housing. The smaller box to the right the tungsten housing.

10. Remove the D_2 bulb housing as follows:

10.1 Loosen the three captive spring screws, as shown in Figure A-33.

10.2 Carefully lift off the D_2 housing without disturbing the other components on the source cover base plate.

The housing may be hot. Wait until the bulb is cool before removing it.

10.3 If the D_2 bulb is off, proceed to step 11. If the bulb is emitting a purple glow, proceed to step 24.

11. Disconnect the three-wire cable that feeds power to the D_2 bulb, as shown in Figure A-34.

12. The D_2 bulb is glued into a flange held in place by one pin and two 4-40 screws. Remove the two screws with a 3/32" hex-key as shown in Figure A-34. Retain the screws.

Do not remove the screws from the mounting fixture. Removing the screws from the mounting fixture can cause misalignment.

The bulb may be hot. Wait until the bulb is cool before removing it.

13. Push the bulb up from the bottom by pushing on the cable. Wiggle it from side to side to free it from the alignment pin, if necessary. Set the old bulb aside.

Do not touch the D_2 bulb with bare fingers. Use gloves. Finger oil can damage the new bulb.

14. Using gloves, remove the new bulb from its plastic bag.

15. Drop the two 4-40 screws (Step 12, above) into the mounting flange.

16. Feed the cable connector down through the mounting plate. Make sure that the slot in the bulb flange goes over the pin on the mounting plate. Work the bulb down over the alignment pin. Tighten the two screws with the 3/32" hex-key until it is just snug.

17. Connect the cable connector to the three-wire cable, as shown in Figure A-34.

18. Replace the D2 housing. Finger tighten the three captive spring screws shown in Figure A-33.

19. Replace the UV source cover shown in Figures A-32, and A-33. Gently lower this cover over all components.

    It is a snug fit, but does not require force if you align it properly. Use the black thumb screws (shown in Figure A-32) as alignment guides.

20. Finger tighten the black thumb screws on the front and right sides and the captive spring screw on the left side of the box, (Figure A-32.)

21. Work the outer silver cover back into place. Align the cover with the two studs that protrude from the bottom of the cover to line up with the two interlock buttons, (Figs A-26, A-27).

When the outer silver cover slides securely in place, the red light on the interlock assembly box should light up.

21.1 Tighten the spring loaded screw by hand until the latch springs shut.

22. When the interlock is active and the red light in the UV interlock assembly box is on, the D2 bulb takes about 1 minute to light.

The LAMP light on the Deuterium power supply illuminates when the lamp is running. If the RESTART lamp lights intermittently, something is wrong with the bulb or the cable connections. If this happens, turn off the power supply and check the bulb connection. The LAMP and RESTART lights are shown in Figures A-30 (DUV) and A-31 (DUVI).

23. When the LAMP indicator lights up and remains on, replace the robot module front panel. Before you perform any measurements, let the new bulb warm up for 30 minutes. You should check the approximate signal levels in about 5 minutes.

24. If the bulb emits a purple glow, the interlock is not properly disabled. If this happens, follow these steps:

24.1 Replace the D_2 housing until you can verify that the bulb is off.

24.2 Turn OFF the D_2 power supply switch shown in Figures A-30 (DUV) and A-31 (DUVI)

24.3 **Proceed with step 11**.

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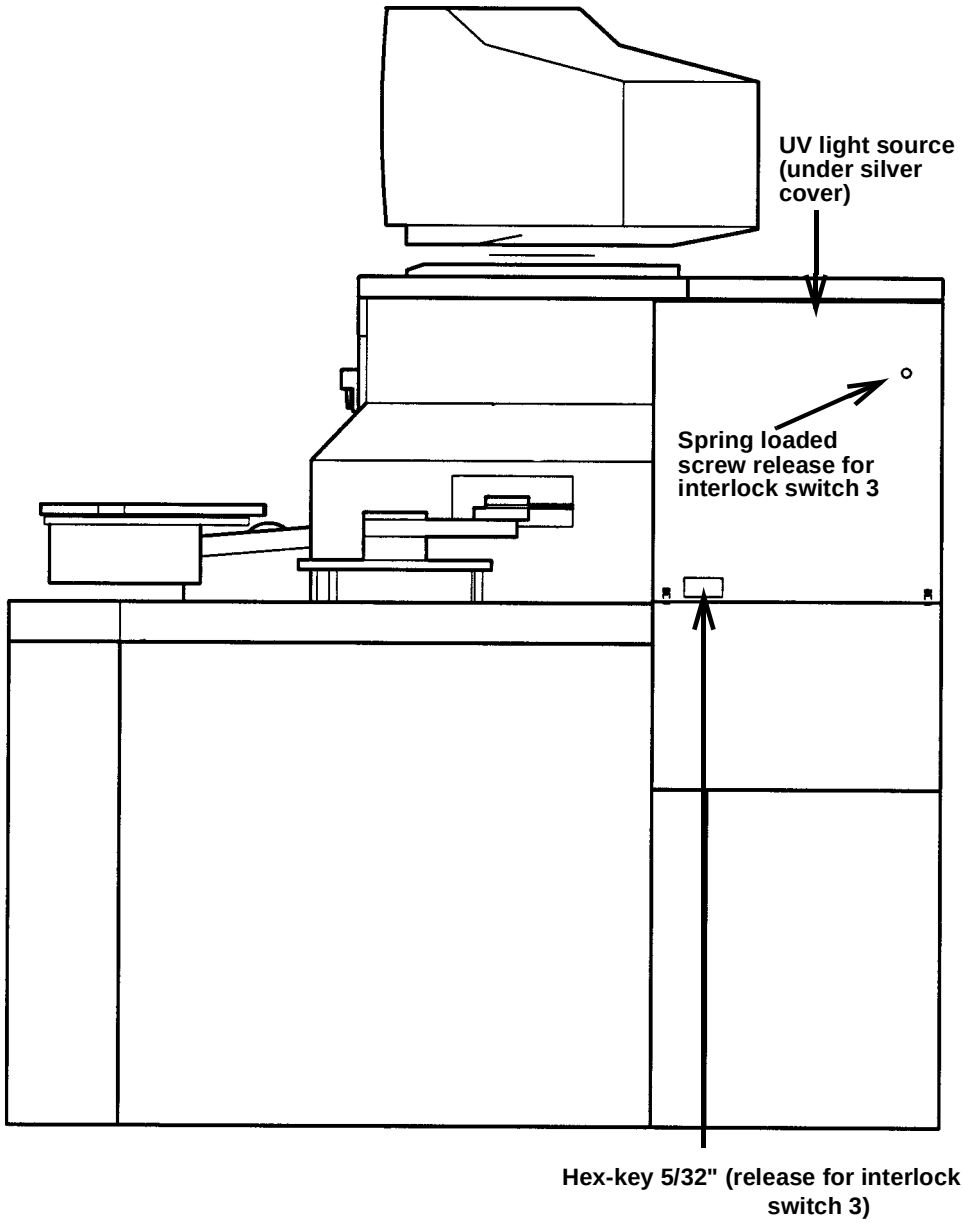
Figure A.26 DUV screw and hex-key release


UV light source (under silver cover)
Spring loaded screw release for interlock switch 3
Hex-key 5/32" (release for interlock switch 3)

Interlock switch 3 and UV light source

Figure A.27 DUVI screw and hex-key release (side panel)

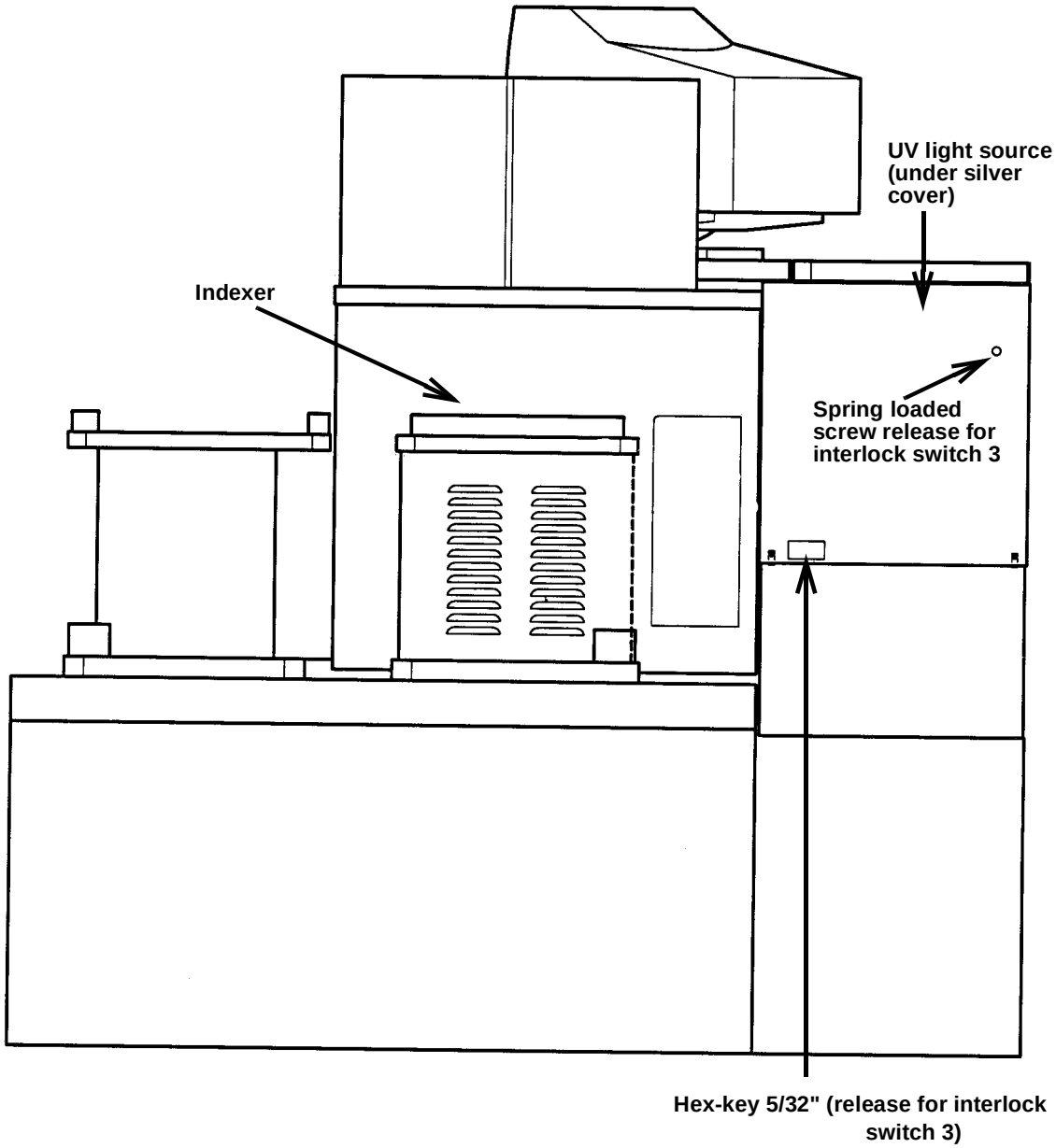

UV light source (under silver cover)
Indexer
Spring loaded screw release for interlock switch 3
Hex-key 5/32" (release for interlock switch 3)

Figure A.28 Loosen DUV hex-key springs

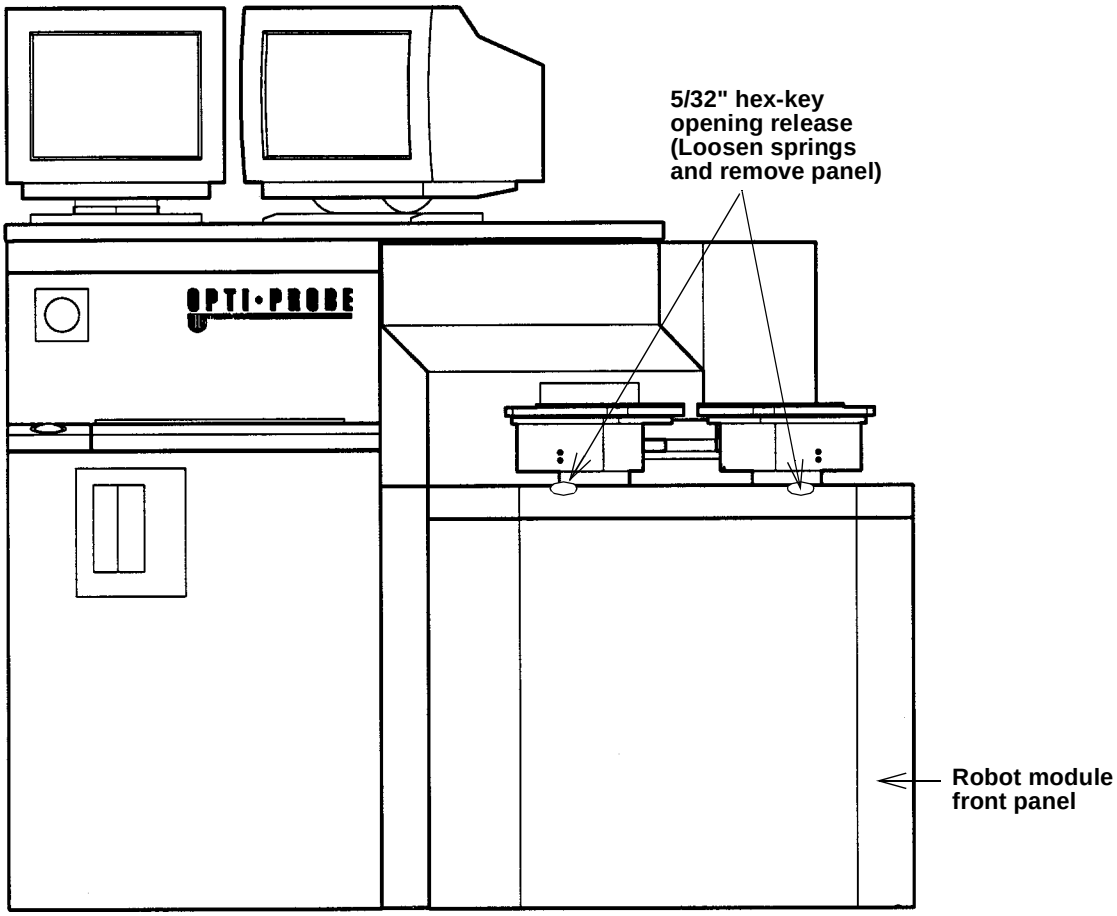


Figure A.29 Checking that the DUV power indicator is OFF

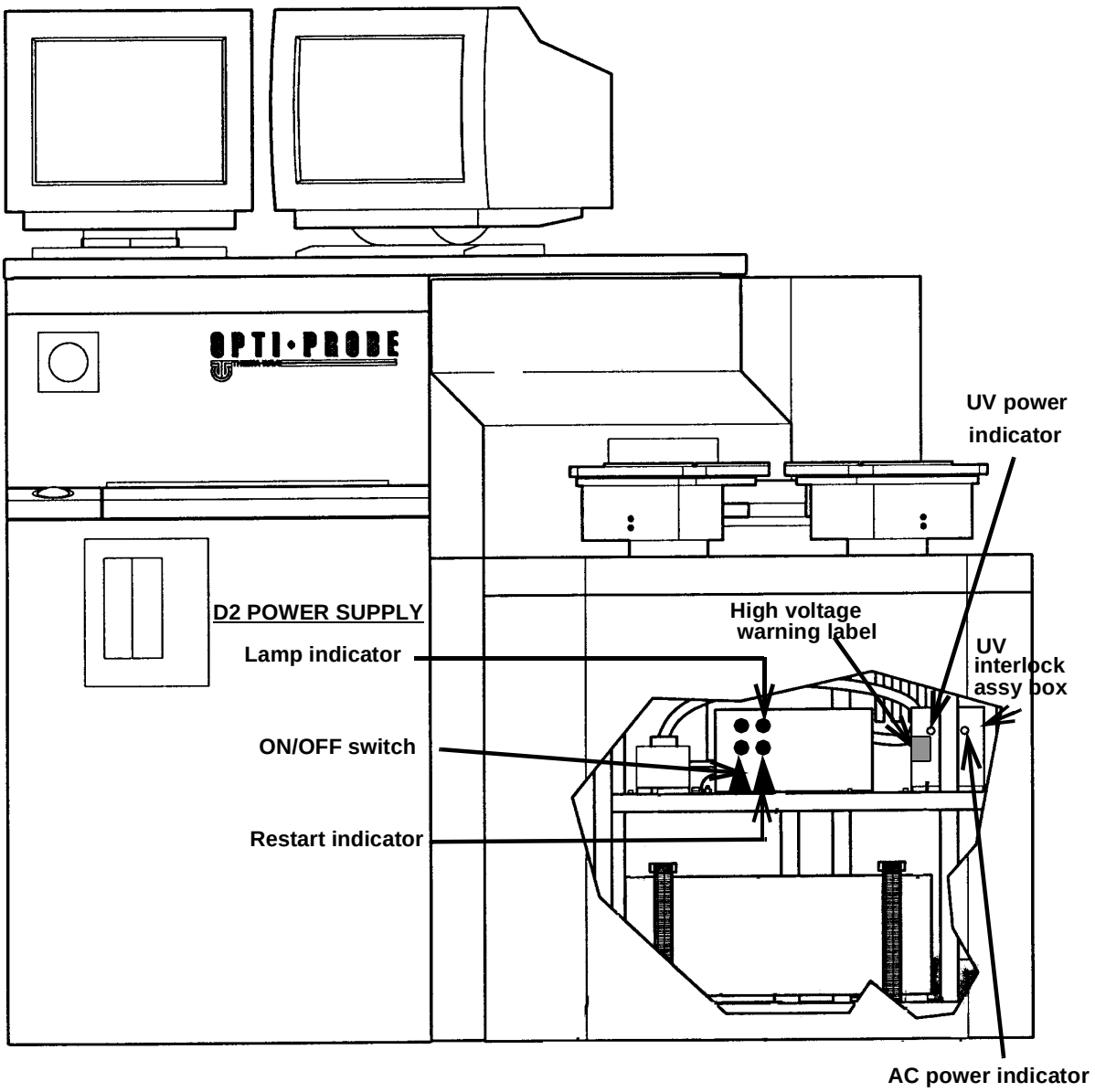


Figure A.30 Checking that the DUVI power indicator is OFF

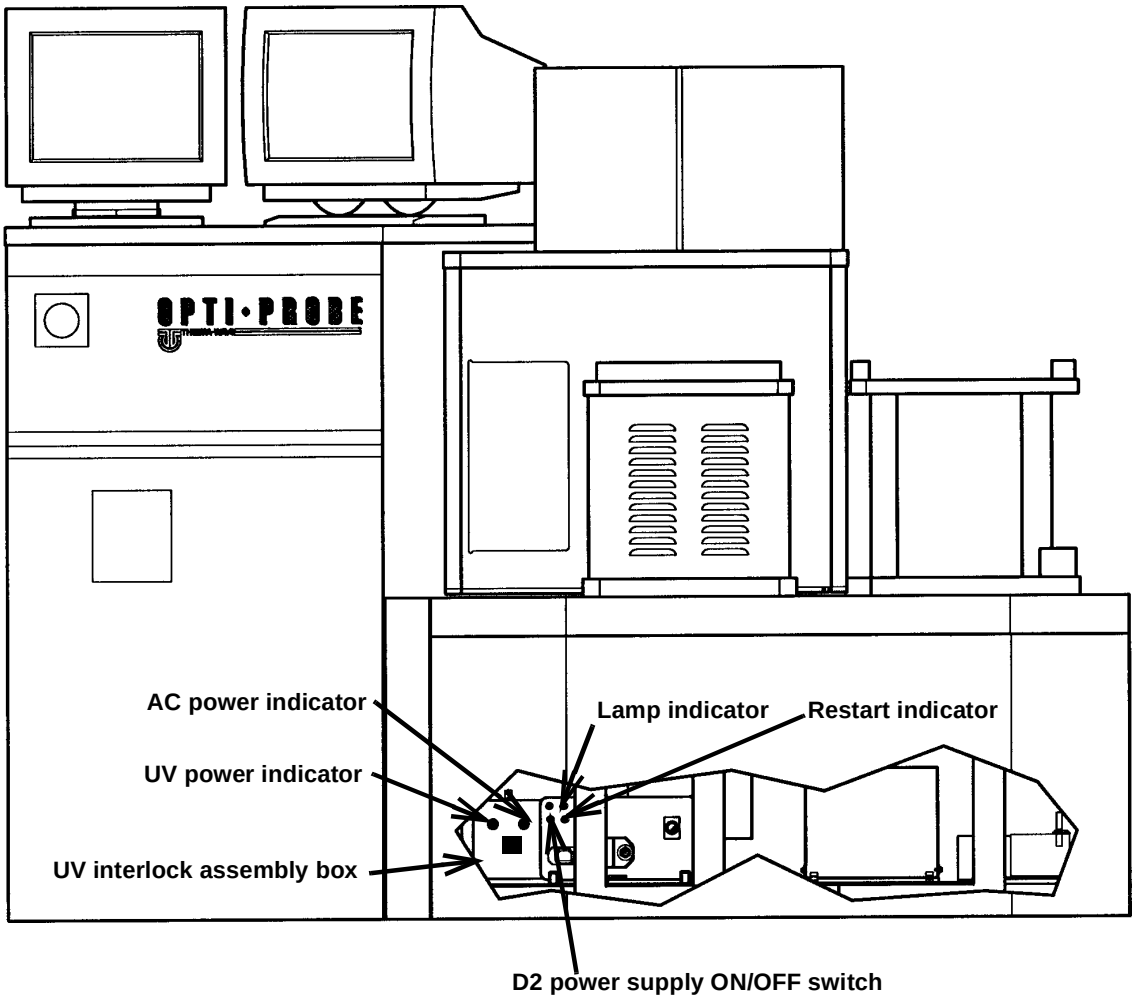


Figure A.31 Removing the UV light source cover

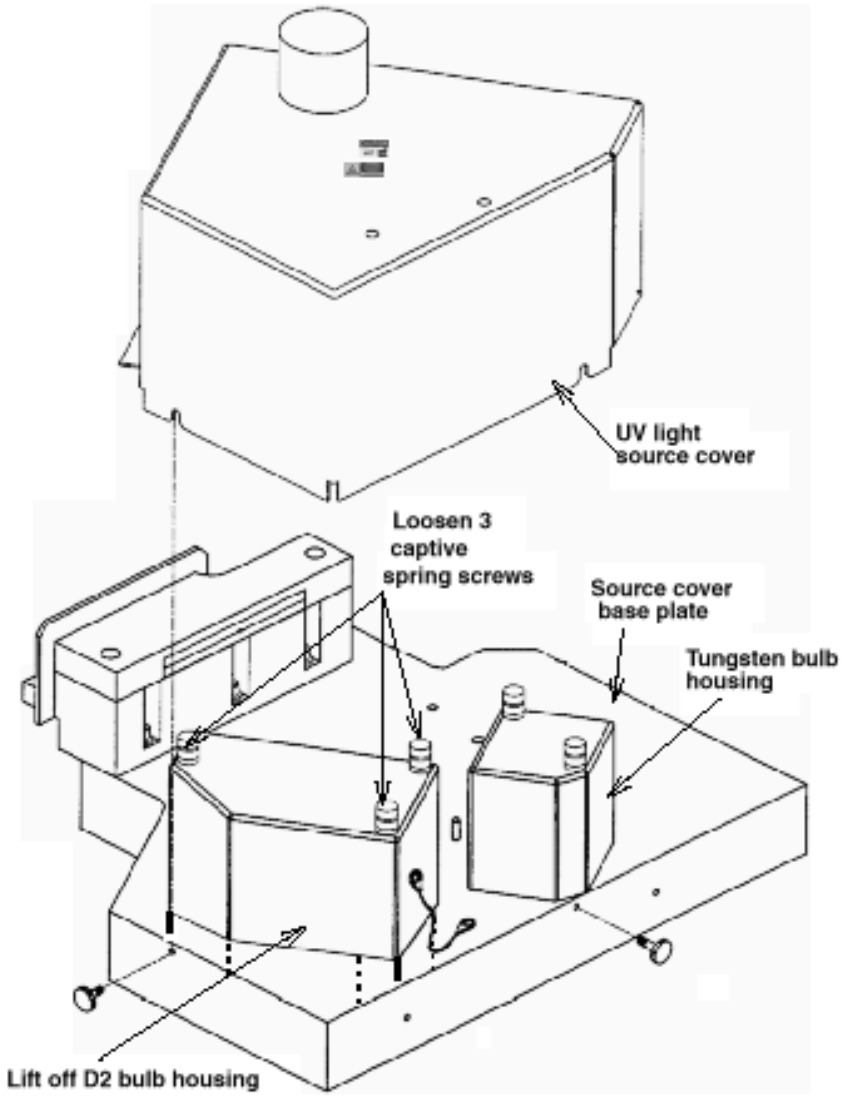

UV light source cover
Loosen 3 captive spring screws
Source cover base plate
Tungsten bulb housing
Lift off D2 bulb housing

Figure A.32 Removing the deuterium bulb housing

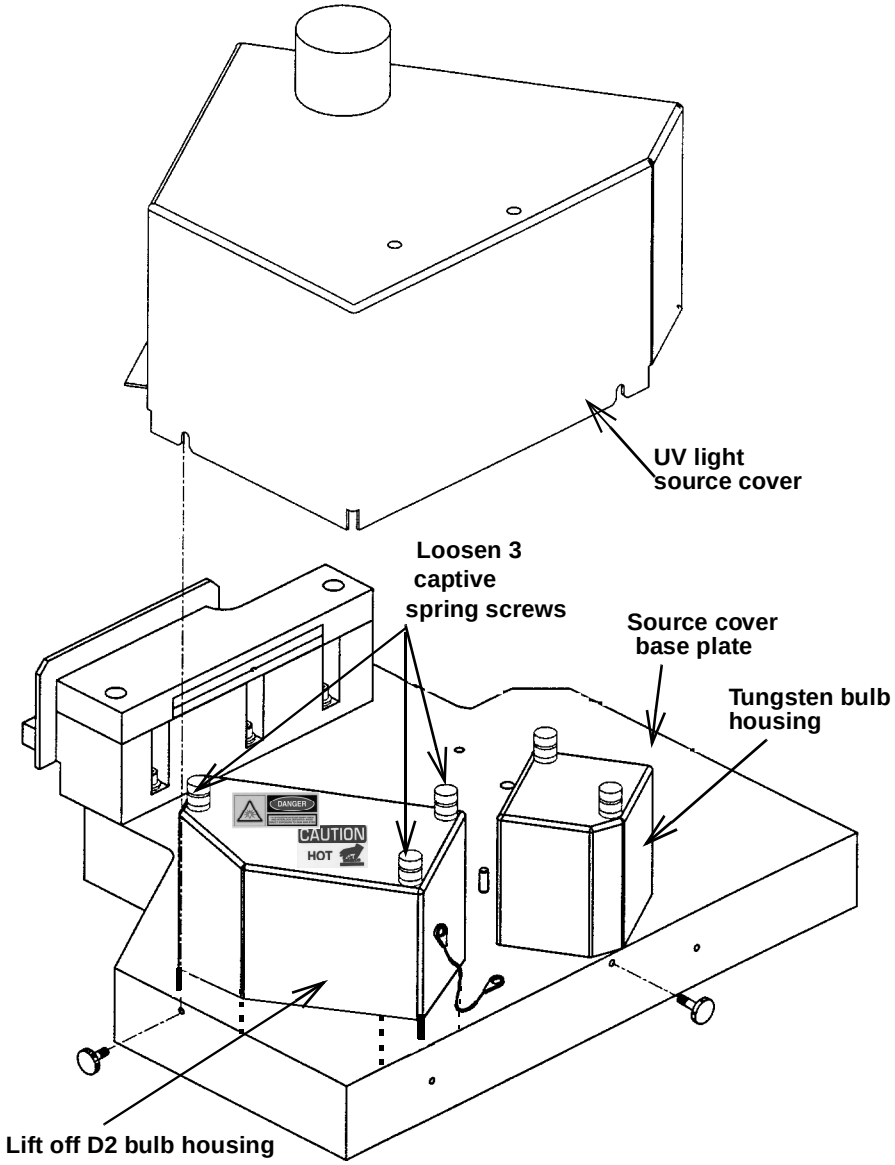
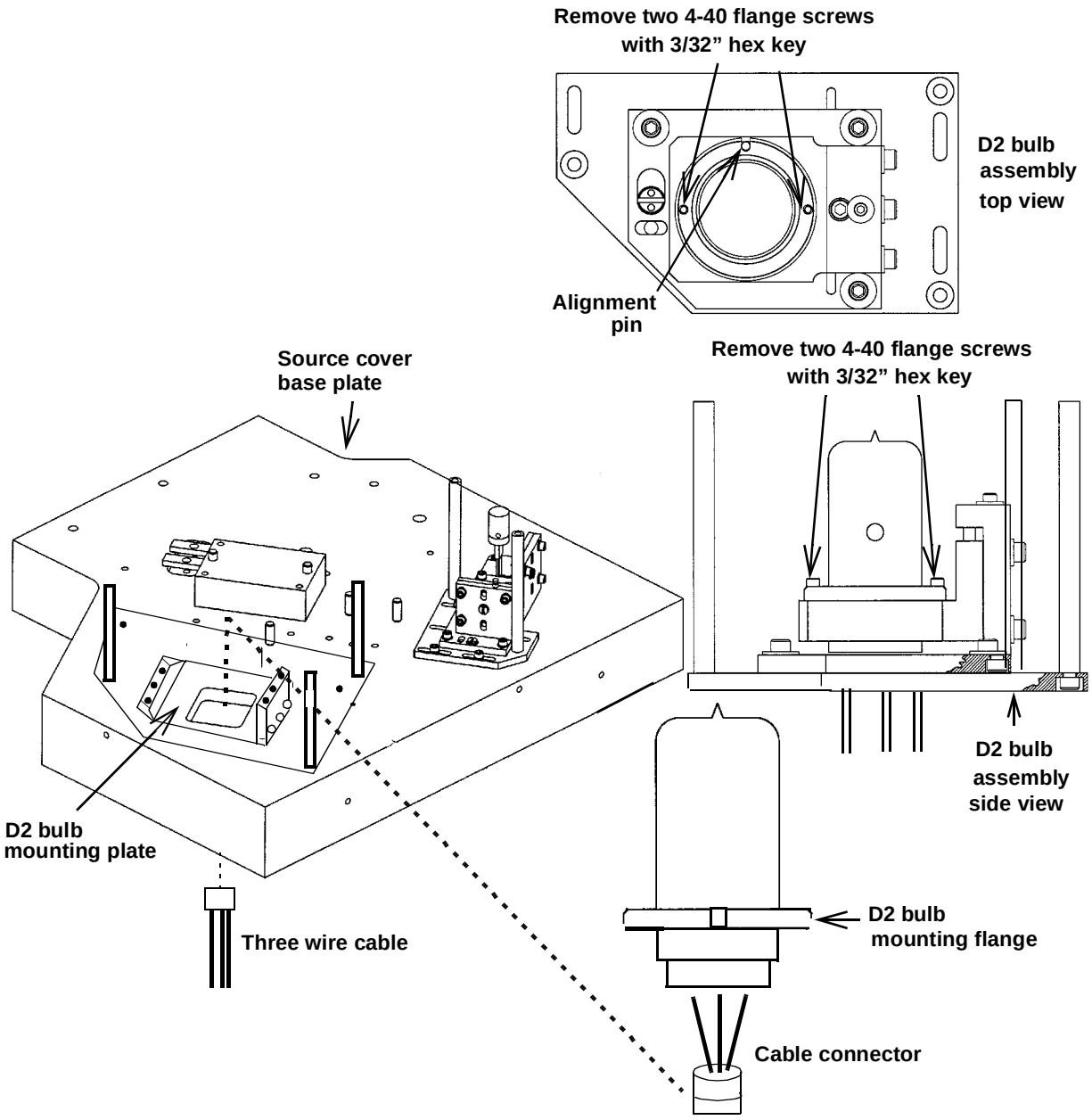


Figure A.33 Removing the deuterium bulb



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B

FILM LIBRARY SELECTIONS

The Film Library provides the following TWI defined standard film stacks and measurement parameters, displayed by process type and film type in alphabetical order.

CVD

CVD:	BPSG/Si	{t1}
CVD:	BPSG[rough]/Si	{t2}
CVD:	Nit[PECVD]/Si	{t1}
CVD:	Nit[PECVD]/Si	{t1,n1}
CVD:	ONO	{t1}
CVD:	ONO	{t1,t2}
CVD:	ONO[low index]	{t1}
CVD:	ONO[low index]	{t1,t2}
CVD:	Ox[CVD]Si	{t1}
CVD:	Ox[CVD]Si	{t1,n1}
CVD:	oxynit/Si	{t1,n1}
CVD:	Ti/Si	{t1,k1}
CVD:	TiN/Al	{t1,k1}
CVD:	TiN/Si	{t1,k1}
CVD:	TiN/Ti	{t1,k1}

Diffusion

DIF:	Nit/Ox/Si	{t1}
DIF:	Nit/Si	{t1}
DIF:	Nit/Si	{t1,n1}
DIF:	Nit[<500A]/Ox/Si	{t1} *
DIF:	ONO[thin, low index}	{t1} *

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DIF:	ONO[thin]	{t1} *
DIF:	Ox/Si	{t1}
DIF:	Ox/Si	{t1,n1}
DIF:	Ox[<1000A]/Poly/Ox/Si	{t1,t2} *
DIF:	Poly[as-dep]/Ox/Si	{t1}
DIF:	Poly[as dep]/Ox[<500A]/Si	{t1}
DIF:	a-Si/Ox/Si	{t1}

* Ellipsometer models only

Inter-layer dielectrics

ILD:	Ox/Al	{t1}
ILD:	Ox/Ti	{t1}
ILD:	Ox/TiN/Al	{t1}
ILD:	Ox/TiN/Ti	{t1}

Lithography

LTH:	Polyimide/Si	{t1}
LTH:	Polyimide/Si	{t1,n1}
LTH:	Resist/BPSG/Si	{t1,t2}
LTH:	Resist/Ox/Si	{t1,t2}
LTH:	Resist/Si	{t1}
LTH:	Resist/Si	{t1,n1}

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C

STANDARD TEMPLATES

Figure C.1 ASTM-6-SITE

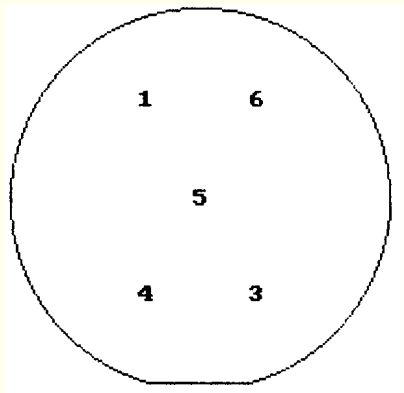

Figure C.2 ASTM-10-SITE

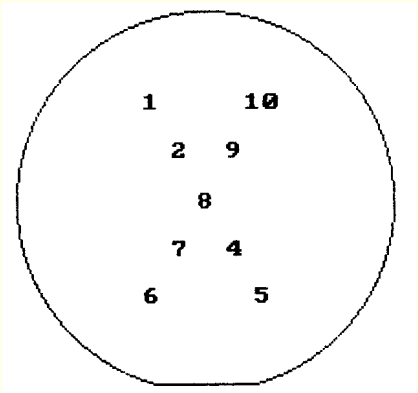

Figure C.3 SEMI-6-SITE

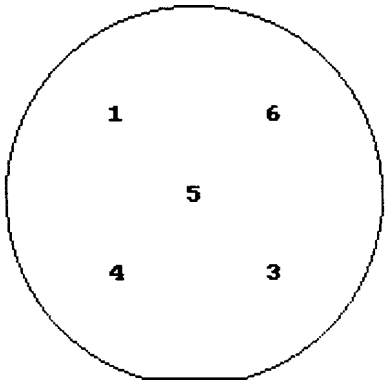

Figure C.4 SEMI-10-SITE

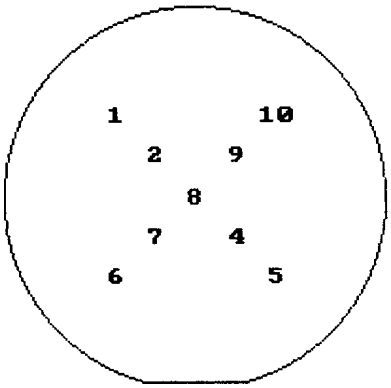

Figure C.5 TCBLR-5-SITE

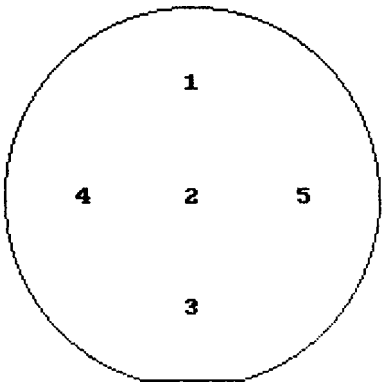

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Figure C.6 TCBLR-9-SITE

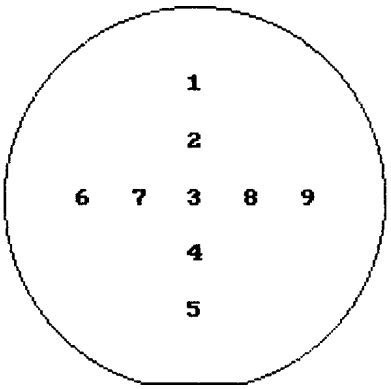

Figure C.7 TCBLR-17-SITE

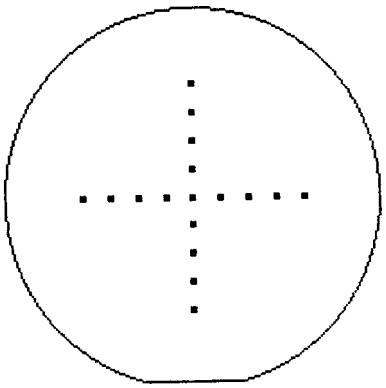

Figure C.8 TCBLR-25-SITE

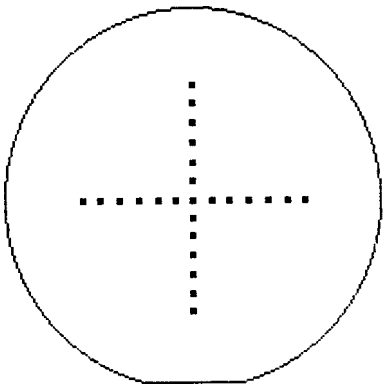

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Figure C.9 VERT-3-SITE

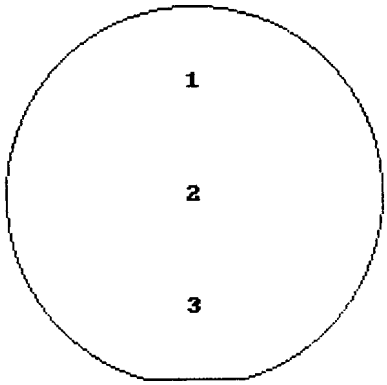

Figure C.10 HORZ-3-SITE

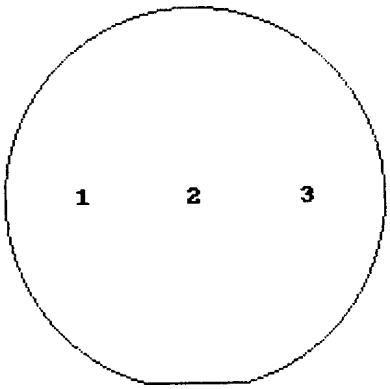

Figure C.11 STAG-9-SITE

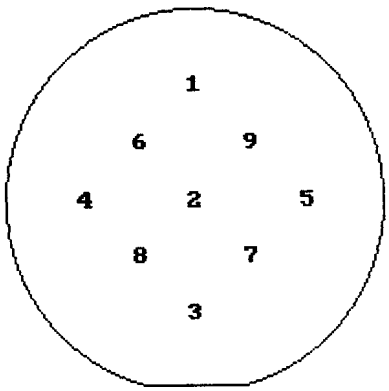

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Figure C.12 STAG-13-SITE

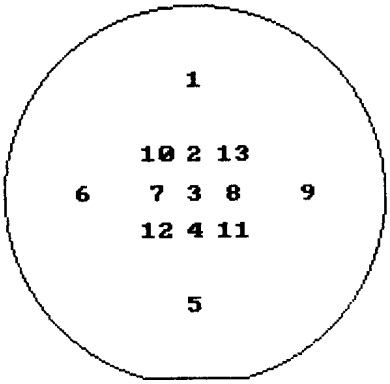

Figure C.13 STAG-17-SITE

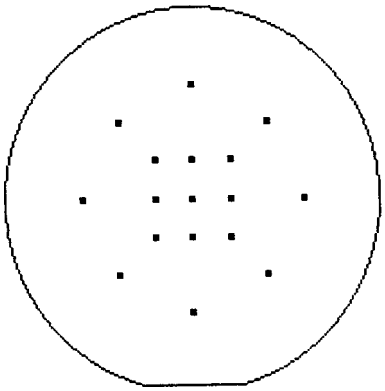

Figure C.14 STAG-21-SITE

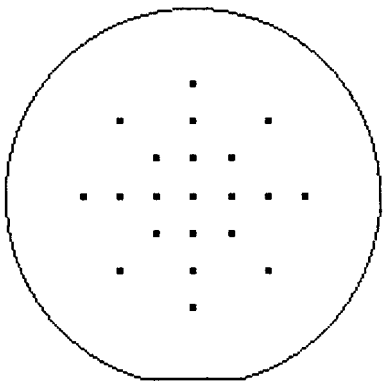

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Figure C.15 STAG-25-SITE

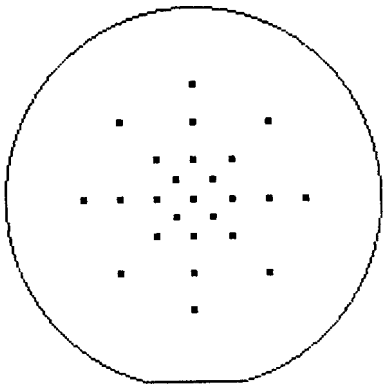

Figure C.16 STAG-29-SITE

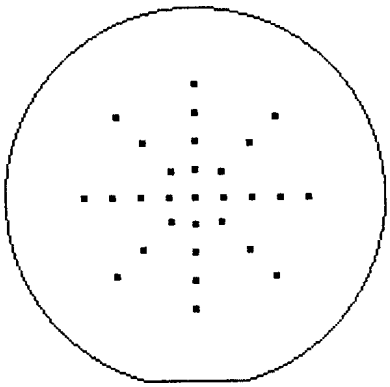

Figure C.17 STAG-33-SITE

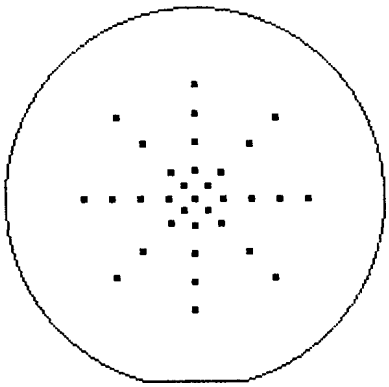

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Figure C.18 STAG-37-SITE

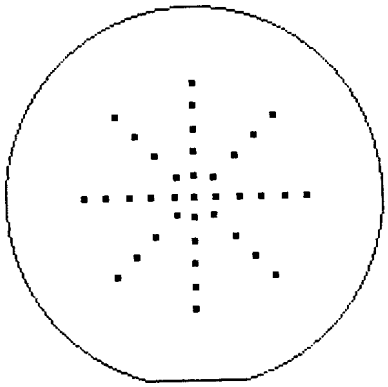

Figure C.19 STAG-41-SITE

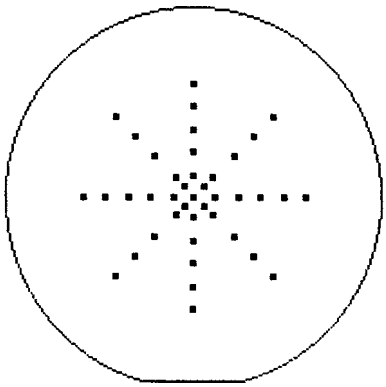

Figure C.20 STAG-45-SITE

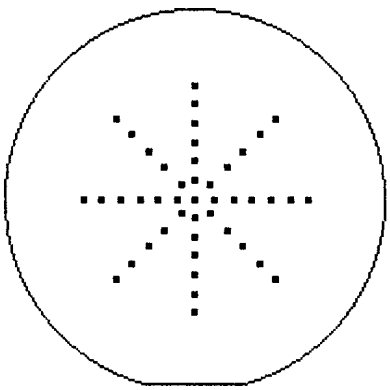

Figure C.21 STAG-49-SITE

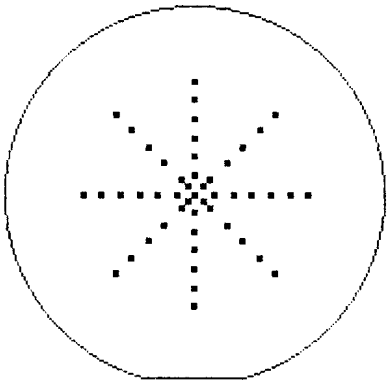

Figure C.22 X-5-SITE

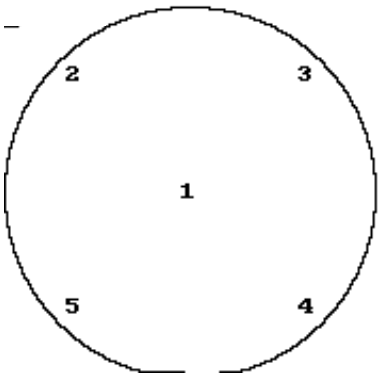

Figure C.23 TBROW-7-SITE

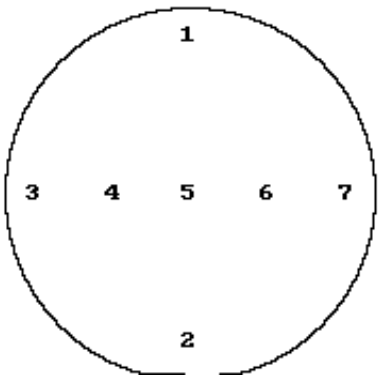

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Figure C.24 XSPRL-9-SITE

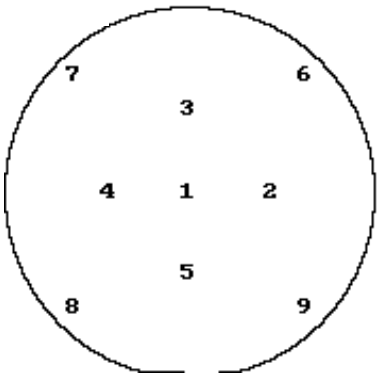
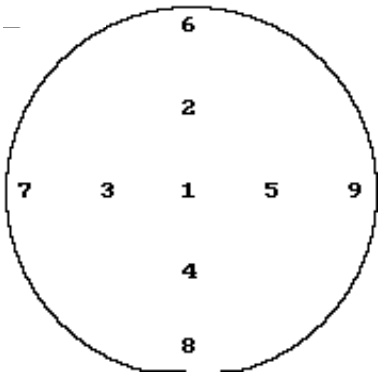


Figure C.25 SPRL-9-SITE



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D

SIGNAL TOWER CONFIGURATION

A blank Signal Tower Configuration Table is provided on the following pages. You should copy this table and enter your organization's light output for each of the applicable Opti-Probe machine events (or states). You should also enter your organization's name for each of these TWI defined machine states. Definitions are provided following the table.

Opti-probe Signal Tower Configuration Table — Therma-Wave Inc.

Prepared For _____

Date _____

Sheet 1 of 3

Line Num	Category	Therma-Wave Event Name or State Name	Customer State Name	Outputs (0 = OFF, 1 = ON, F = FLASH, X = NO CHANGE) G	A	R	B	Comments
	General Events & General States	GemBADDOWNLOAD (CEID 7)						
		ALARM_BEGIN						
		ALARM_END						
		OPERATOR_INTERVENE_BEGIN						
		OPERATOR_INTERVENE_END						
		IDLE_BEGIN						
		IDLE_END						
	Cassette Events & Port States	CassettePresent (CEID 401)						
		CassetteNotPresent (CEID 402)						
		RemoveCassette (CEID 403)						
		MountCassette (CEID 404)						
		CassetteStart (CEID 405)						
		CassetteComplete (CEID 406)						
		CassetteStop (CEID 407)						
		CassetteErrorRemove (CEID 408)						
		CassetteResetRemove (CEID 409)						
		CassetteErrorSize (CEID 410)						
		CassetteResetSize (CEID 411)						
		MIR_1						
		MOR_1						
		NO_MORMIR_1						

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Opti-probe Signal Tower Configuration Table — Therma-Wave Inc.

Prepared For _____

Date _____

Sheet 2 of 3

Line Num	Category	Therma-Wave Event Name or State Name	Customer State Name	Outputs (0 = OFF, 1 = ON, F = FLASH, X = NO CHANGE) G	A	R	B	Comments
		MIR_2						
		MOR_2						
		NO_MORMIR_2						
	Process Events & Process States	ProcessWaferOnStage (CEID 501)						
		ProcessInitComplete (CEID 502)						
		SelectJobFile (CEID 503)						
		AutoLotStart (CEID 504)						
		AutoLoadWafer (CEID 505)						
		AutoLoadComplete (CEID 506)						
		AutoMeasComplete (CEID 507)						
		AutoHaltCommand (CEID 508)						
		AutoUnloadComplete (CEID 509)						
		AutoLotComplete (CEID 510)						
		SelfTestStart (CEID 518)						
		SelfTestComplete (CEID 519)						
		AutoProcessError (CEID 520)						
		AutoErrorReset (CEID 521)						
		ProcessMeasComplete (CEID 524)						
		ProcessAutocalStart (CEID 525)						
		PrcssAutocalComplete (CEID 526)						
		ProcessAutolotError (CEID 527)						
		SelectJobFileFail (CEID 528)						
		PrcssRecallDatAvail (CEID 529)						
		ProcessDataConfirmed (CEID 530)						

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Opti-probe Signal Tower Configuration Table — Therma-Wave Inc.

Prepared For _____

Date _____

Sheet 3 of 3

Line Num	Category	Therma-Wave Event Name or State Name	Customer State Name	Outputs (0 = OFF, 1 = ON, F = FLASH, X = NO CHANGE)				Comments
				G	A	R	B	
		SELFTEST_ALARM_BEGIN						
		SELFTEST_ALARM_END						
	Automation States	ONLINE_REMOTE						
		ONLINE_LOCAL						
		OFFLINE						
		SECS_DISABLED						
	Signal Tower Screen Switches	DOWN_BEGIN						
		DOWN_END						
		AVAILABLE_BEGIN						
		AVAILABLE_END						

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Opti-Probe machine event (state) definitions

The Signal tower machine events indicate a transition in the current state of the Opti-Probe. In some cases, the Signal tower can indicate the state of the equipment rather than a transition between states. The following definitions apply to non-SECS events. For SECS related definitions, refer to the "GEM SECS Manual."

ALARM_BEGIN Signal tower alarm begins
Occurs when:
* An error report appears on the equipment operator interfac screen and it is not a Selftest failure

ALARM_END Signal tower alarm ends
Occurs when:
* An error report on the equipment operator interfac screen is acknowledged by the operator and disappears from the operator interface screen.

OPR_INTERVENE_BEGIN Signal tower operator intervention required
Occurs when:
* Presently not defined

OPR_INTERVENE_END Signal tower operator intervention no longer required
Occurs when:
* Presently not defined

IDLE_BEGIN Signal tower idle begin
Occurs when:
* Machine state does not include PROCESS, MIR, MOR, DOWN, SYSTEST, ALARM, or OPERATOR_ACK i.e. the machine is available and not in use.

IDLE_END Signal tower idle end.
Occurs when:
* Opposite of IDLE_BEGIN

MIR_1 Signal tower move in request
Occurs when:
* Single cassette jobfile, selected station becomes empty.

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* Dual cassette jobfile, either station becomes empty.

MOR_1 Signal tower move out request
Occurs when:
* There is no MIR and a cassette measurement completes or a job chain completes

NO_MORMIR_1 Signal tower no move in or move out request
Occurs when:
* Platform state is not MIR_1 and not MOR_1

MIR_2 Signal tower move in request
Occurs when:
* There is no cassette on either or both cassette stations

MOR_2 Signal tower move out request
Occurs when:
* There is no MIR and a cassette measurement completes or a job chain completes

NO_MORMIR_2 Signal tower no move in or move out request
Occurs when:
* Platform state is not MIR_2 and not MOR_2

SELFTEST_ALARM_BEGIN Signal tower self test alarm begins.
Occurs when:
* System test error occurs.

SELFTEST_ALARM_END Signal tower self test alarm ends.
Occurs when:
* System test failure acknowledge.

ONLINE_REMOTE Signal tower SECS online remote
Occurs when:
* Opti-Probe in SECS online remote state
Complementary event when:
* Goes to another SECS state

ONLINE_LOCAL Signal tower SECS online local
Occurs when:
* Opti-Probe in SECS online local state
Complementary event when:
* Goes to another SECS state

OFFLINE Signal tower SECS off line
Occurs when:
* the system initializes and SECS is offline

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* the operator initiates 'Go offline'

Complementary event when:

* the host initiates 'Go online'
* the operator initiates 'Go online'

SECS_DISABLED Signal tower SECS disabled

Occurs when:

* the system initializes and SECS is not installed
* the system initializes and SECS is not enabled

Complementary event when:

* Presently not defined

DOWN_BEGIN Signal tower down begin

Occurs when:

* Set in Signal Tower Switches Screen.
* Set by host.

DOWN_END Signal tower down end

Occurs when:

* Reset in Signal Tower Switches Screen.
* Reset by Host.

AVAILABLE_BEGIN Signal tower available begin

Occurs when:

* Set in Signal Tower Switches Screen.
* Set by host.

AVAILABLE_END Signal tower available end

Occurs when:

* Reet in Signal Tower Switches Screen.
* Reet by host.

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